that it is absolutely harmless, as the product of its firing is hydrogen. Secondly it the most wide spread element in the universe, that is why it is unlimited. Furthermore, it might be use during colonization of one of the most preferable places for extraterrestrial colonization. The name of it is Europe, the moon of Jupiter. It is totally covered with ice layer, which consists of hydrogen. Moreover, there are hydrogenous oceans under the ice layer. Hence, people will be able to use it for producing energy, which will be practically unlimited.

To sum up, if one day there will become a moment, when people will have to leave the Earth, they will have some possible places for creating a new human "Motherland", and at the same time, they will have some ways to provide it with energy. In my humble opinion, the most perspective type of energy for possible colonization is the energy of nuclear decay and nuclear fusion as they have important benefits compared to solar power. They do not depend on light source, such as the Sun.

REFERENCES

1. Harrison A.A. Spacefaring: The Human Dimension. – Berkeley: University of California Press, 2002.
2. Seedhouse E. Lunar Outpost: The Challenges of Establishing a Human Settlement on the Moon. – Chichester: Praxis Publishing Ltd, 2009.
3. Seedhouse E. Martian Outpost: The Challenges of Establishing a Human Settlement on Mars. – Chichester: Praxis Publishing Ltd, 2009.
4. Seedhouse E. Interplanetary Outpost: The Human and Technological Challenges of Exploring the Outer Planets. – Berlin: Springer, 2012.

MODERN METHODS OF THE GASIFICATION

E. Sokolova, A. Zenkov

Tomsk Polytechnic University

High temperature processes of interaction of the organic mass of solid or liquid combustible minerals or products of their thermal treatment with air, oxygen, steam, carbon dioxide or their mixtures, which results in the organic portion of the fuel drawn into combustible gases are called gasification. The raw materials for the process are usually hard coal, brown coal, oil shale and peat [1].

Gasification processes can be classified by the following features:

- calorific value of the gases (MJ/m^3): preparation of gases with low (4.18-6.70), medium (6.70-18.80) and high (31-40) heat of combustion;

- intended gases: for energy (direct combustion) and technological (synthesis, hydrogen production, carbon black production) purposes;

- the particle size of the fuel used: gasification of coarse, fine and dust-like fuels;

- the type of blowing: air, vapor, oxygen, steam-oxygen, steam;

- the method of removal of mineral impurities: wet and dry ash removal, slag tap;

- gasification pressure: atmospheric (0.1-0.13 MPa), medium (2-3 MPa) and high pressure (higher than 2-3 MPa);

- the nature of the gasified fuel movement: in pseudo steady consistently falling layer, in pseudo liquefied (boiling) layer, in a moving stream of dust particles;

- the gasification temperature: low-temperature (800°C), medium-temperature (800-1300°C) and high temperature (above 1300°C);

- the balance of heat in the gasification process: auto thermal (stable temperature is maintained by internal heat sources in the system) and all thermic, i.e. requiring heat input from outside to maintain the gasification process. The external heat supply may be carried out using solid, liquid or gaseous heat transfer agents [1].

There are three methods of solid fuel gasification: entrained-flow, fluidized-bed and moving-bed gasification. The principle of operation, advantages and disadvantages of them are listed below.

Entrained-flow gasification. Widely dispersed very fine particles are radiantly heated to high temperature for slagging and rapid gasification. Some of the issues are: obtaining uniform feed, slurry drying, and separation of gas production from the heat recovery. The volume is determined from conversion time for average particle. These units have a relatively low cold gas efficiency and high O_2 demand.

Hydrodynamically, entrained flow gasifiers are quite simple with respect to the conversion of the coal particle and the reacting gas. They operate in a co-current manner with the solids and gas moving either in up flow or down flow and are characterized as plug flow processes [2]. All entrained-flow gasifiers are of the slagging type, which implies that the operating temperature is above the ash melting point. This ensures the destruction of tars and oils [3].

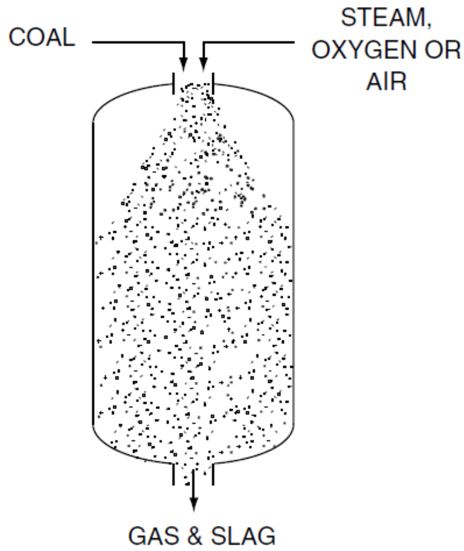

Fig. 1 – Entrained-flow gasifier

Table 1

Typical gas composition for entrained-flow gasifiers [2]

Gasifier	Dry-entrained			Slurry-entrained
Coal type	Lignite	Sub-bit	Bit	Bituminous
Pressure (atm)	30	30	25-30	42
Gas composition (dry)				
CO	62.01	64.48	61.53-64.97	49.46
CO_2	6.88	1.33	0.81-1.63	12.30
H_2	30.42	33.37	30.61-32.08	35.95
N_2	0.34	0.51	0.51-4.80	0.97
CH_4	0	0	0	0.36
H_2S	0.23	0.31	1.33-1.42	1.33

Fluidized-bed gasification. Air flow rate is beyond the stability of the dense layer at gasification in a fluidized bed. Fuel particles move apart, their movement resembles the movement of the boiling liquid, causing the volume of the layer is increased by 1.5-3 times [4]. As a result, the gas generators of this type have a higher specific productivity.

After the fuel is preconditioned (dried to a moisture content of 7-12%, and milled to a 0.5-12 mm), it is supplied to the gasifier. Prepared coal is continuously fed from a bunker on the grate. Blowing is supplied through the grate. The pressure of blowing should be enough to set fuel in motion. These gasifiers operate at steam-oxygen blast. 80% of the blowing is carried out through the grate, while 20% is carried out through tuyeres located above the fuel bed. This design reduces the removal of small coal particles from the layer with the gas flow. For the same purpose, the gasifier is made high [4].

Part of the ash from the gasifier is supplied to the ash collector, from where it is constantly removed. Another part of the ash is imposed by gas flow and is captured by dust collectors.

Disadvantages of this method: the gasification process must be performed at a temperature below the softening point of the ash and large size of the installation [4].

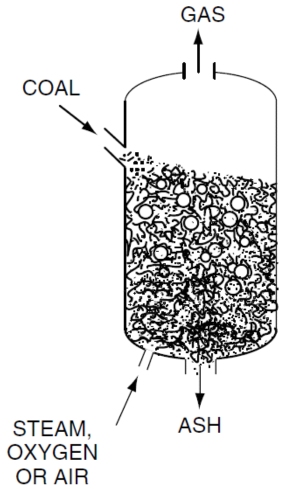

Fig. 2 – Fluidized-bed gasifier

Table 2

Typical product compositions for air-blown fluidized-bed gasifiers [2]

Coal type	Lignite	Bituminous
Pressure (atm)	1	5-30
Gas composition (dry)		
CO	22.5	12.54-30.7
CO_2	7.7	6.4-4.47
H_2	12.6	14.4-28.56
N_2	55.7	47-54.3
CH_4	0.8	0.2-3.59

Moving-bed gasification. The gasifier operating on this principle works as follows. Fuel is fed into the gasifier from the top from the gateway system. Blowing is supplied through tuyeres in the lower part of the fuel layer. At the output of the blast from the tuyere a concentrated high temperature combustion hearth is formed, which ensures the melting and removal of ash. Temperature reaches 1750-1900°C at the core of the combustion. It provides a forced kinetics of the reduction reactions above the combustion zone. The volatiles are emitted in the upper zone. They enrich syngas, but contribute to the formation of resins vapor [5].

The main disadvantage of this method of gasification is the size of the pieces of fuel. There are a lot of small pieces in coal. It makes the gasification process more complicated. It decreases gasifiers performance, increases ash, degrades the quality of the gas and affects other performance indicators. Therefore, fuel is sifted before gasification and considerable part of it is directed to be used in other installations, for example, furnace of a boiler.

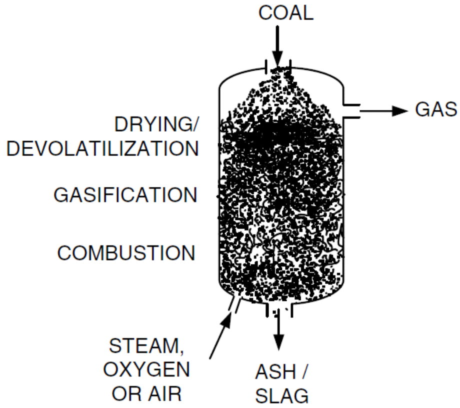

Fig. 3 – Moving-bed gasifier

Table 3

Typical product compositions for air-blown moving-bed gasifiers [2]

	Air-blown	
	Dry bottom moving bed	
Coal type	Subbituminous	Bituminous
Pressure (atm)	5.3-20	1
Gas composition (dry)		
CO	8-17.4	22.7-27.8
CO_2	13.1-17.1	5.9-6.3
H_2	14.4-23.3	16.2-16.6
N_2	38.5-53.7	48-50.5
CH_4	2.5-5.1	1.7-3.6
H_2S	0-0.2	0

Conclusion. Gasification, at least of coal, is in one sense an old technology, having formed the heart of the town gas industry until the widespread introduction of natural gas. With the decline of the town gas industry, gasification became a specialized, niche technology with limited application. After substantial technical development, gasification is now enjoying a considerable renaissance. This is documented by the more than thirty projects that are in various stages of planning or completion at the present time.

In its widest sense the term gasification covers the conversion of any carbonaceous fuel to a gaseous product with a useable heating value.

The future of gasification is intimately intertwined with the future of energy and energy policy. It is generally recognized that human development cannot continue to base its economy on fossil fuels in the present manner forever. Gasification can play an important role in the transition between fossil fuels and a fully "renewable world". First, in the move toward a hydrogen economy, one can expect that the hydrogen will be produced directly from fossil fuels rather than by electrolysis. Second, gasification is a key technology for more efficient power generation from coal and heavy oils with the best environmental performance. And third, gasification provides the best option for producing concentrated carbon dioxide streams that may have to be sequestered during the transition in order to reduce the emission of greenhouse gases [3].

REFERENCES

1. Gasification // Wikipedia. – [Электронный ресурс]. – Режим доступа: http://wikipedia.ru (дата обращения: 09.11.2014).
2. Gazogenerator. – [Электронный ресурс]. – Режим доступа: http://suslovm.narod.ru/Gazogenerator.html (дата обращения: 09.11.2014).
3. Higman Ch., van der Burgt M. Gasification. –Elsevier, 2003.
4. Shadle L.J., Breault R.W. Integrated gasification combined cycle. U.S. Department of Energy, National Energy Technology Laboratory. – Morgantown, 2011.
5. Suchkov S.I. Development of methodology for calculating fuel gasification in the hearth gasifier. – VTI, 2012.

DEVELOPMENT OF THE PROGRAM FOR RESEARCH OPERATING MODES OF THE POWER AUTOTRANSFORMER

I. Tsoy, N. Kosmynina
Tomsk Polytechnic University

The power autotransformer has the following operating modes: the autotransformer, transformer and combined operating modes [1].

At department of electric power systems of Power engineering Institute of Tomsk polytechnic university the program for the analysis of operating modes of autotransformers was developed. This program doesn't meet requirements of the modern interface and has weak opportunities regarding verification of data.