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Conversion of oxidative combustion into powerful thermal and light energy

Kholmurad Khasanov[1]*
Department of Engineering Physics and Astronomy, Samarkand State University, University Boulevard, 15, Samarkand, 140104, Uzbekistan; drkholmurad@gmail.com (K.K.)

Abstract: The phenomenon of transformation of the oxidative combustion of natural coolants - coal, methane, propane, etc. - into the production of powerful light and thermal energy when their combustion zone is exposed to supersonic spiral-twisted jets of dusty plasma from a dynamic emitter has been experimentally discovered. The phenomenon occurs without emissions of harmful substances from chemical combustion that contribute to the greenhouse effect. The structure of dusty plasma jet is a self-compressing double helix with collective resonant oscillations. The phenomenon opens up a new type of energy production, connected with a conversion of coal into aluminosilicate minerals, etc.
Keywords: *Double helix, Energy radiation, Greenhouse effect, Supersonic jet, Ultrasonic.*

1. Introduction

A dusty (or complex) plasma is a plasma containing ions, electrons, and nanometer or micrometer-sized particles suspended in it [1]. Dusty plasmas are unusual states of matter where the interactions between the dust grains can be collective and are not a sum of all pair particle interactions [2]. Dusty plasmas are of special interest, because they can form liquid (that is, disordered) and crystalline (that is, ordered) states [3-5]. The major properties of dusty plasmas as a state of matter are shown to be determined by the collective interaction of two coupled fields, the electrostatic field and the flux field [6].

Dusty plasma is capable of exhibiting various properties and forms of self-organization, which made it possible to consider it as a model analogue of living matter [7]. In particular, under certain conditions it exists in the form of spiral dust structures, similar to DNA heredity molecules [7, 8]. In particular, such shape of a double helix is observed in the configuration of one of the cosmic dust nebulae [9].

Analysis shows that if helical dust structures are formed in space, they can have bifurcations as memory marks and duplicate each other, and they would reveal a faster evolution rate by competing for 'food' (surrounding plasma fluxes). These structures can have all necessary features to form 'inorganic life' [7]. The helical dust structures, after they are formed, resemble features similar to those of DNA. In particular, they can transfer information from one helical structure to another via the dust convective cells surrounding any bifurcation of the helical structure. Under certain conditions a dust plasma system can also display characteristics of an active medium with the micron-sized particles converting energy of the ambient environment into motility and thereby becoming active [10].

In the experiments described below, a supersonic jet of dusty plasma is accompanied by ultrasonic vibrations and flashes of light in it [11-14]. Ultrasonic vibrations in dynamic dusty plasma with liquid droplets can lead to sonoluminescence [15], which manifests itself as flashes of light due to cavitation in the droplets. The maximum temperature in the cavitation bubble can reach 25000-100000^{0}K [16, 17].

Observed flashes of light may lead to photolysis [18-20]. In astrophysics, photodissociation is one of the most important processes of destruction and formation of new molecules [21]. Ultraviolet

* Correspondence: drkholmurad@gmail.com

photons play a critical role in interstellar and circumstellar chemistry [22]. Ionospheric and space dusty plasmas also represent a traditional branch of dusty plasma research [1]. All these features of the plasma-dust jets should be taken into account when theoretically understanding in the future the described results on the discovered phenomenon of powerful termo and light radiation when exposed to coal minerals and natural hydrocarbons by supersonic spiral-twisted dust plasma jets.

On Earth, chemical combustion of coal and other combustible substances is widely used in industry, causing massive emissions of carbon dioxide and other greenhouse gases into the atmosphere, creating the global problem of global warming and climate change [23]. The phenomenon described in the article can be considered as an alternative to the industrial use of chemical combustion of coal in order to combat the greenhouse effect and global warming on Earth.

2. Material and Methods

The experiments used an author's supersonic dynamic emitter [24]. It contains an annular nozzle made of bronze with a central cone that can extend beyond the nozzle body to different distances by experimenter (Figure 1).

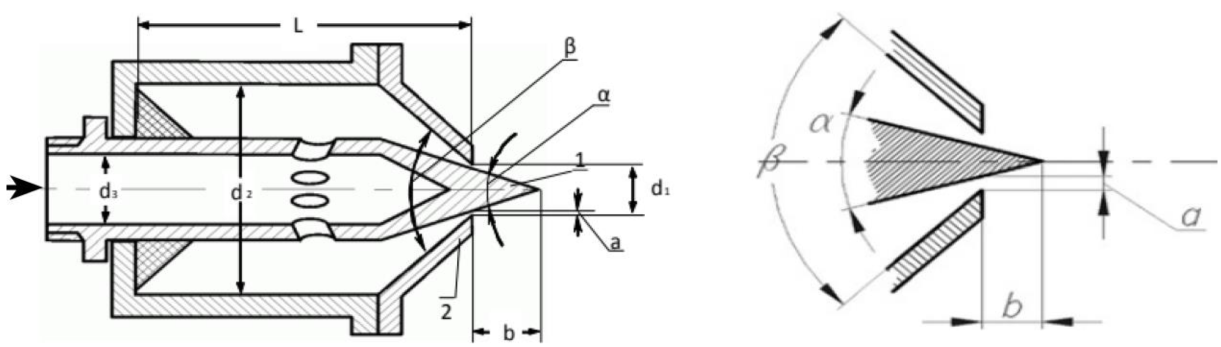

Figure 1. Design of the dust plasmotron with central cone. Left: general diagram of the plasmatron. Right: the exhaust part of the plasma torch with the nozzle extended. Denotations: 1 - the central cone with diameter d_3 = 25 mm and the angle α = 30°, 2 - the truncated cone of the pre-chamber with diameter d_2 = 60 mm and the angle β = 60°; d_1 is a diameter of inlet of the nozzle; the clearance of the controlled critical cut of the slit a = 0.3 - 0.6 mm, the external part of the internal cone b = 3-6 mm, a length of pre-chamber L = 150 mm.

Cooled atmospheric air with a temperature of 253^0K-258^0K at the same ambient temperature was supplied to the emitter input under a pressure of 4-6 bar. At the same time, a supersonic jet of dusty plasma with ultrasonic vibrations and local light flashes in it flowed out of the plasmotron. This jet of dusty plasma has the appearance of a double helix, shown in Fig. 2 and reminiscent of the double helix of DNA, as well as the double helix configuration of one of the cosmic dust nebulae [9]. A distinctive feature of an outflowing spiral jet is its self-compressing structure, decreasing in cross-section [12]. The degree of protrusion of the central cone in the direction of the flow allows you to regulate the features of the outflowing plasma. In particular, depending on the degree of this protrusion, a given plasma spiral can be right-handed or left-handed. Fig. 2 shows a visualization of plasma-dust jets using various technical means.

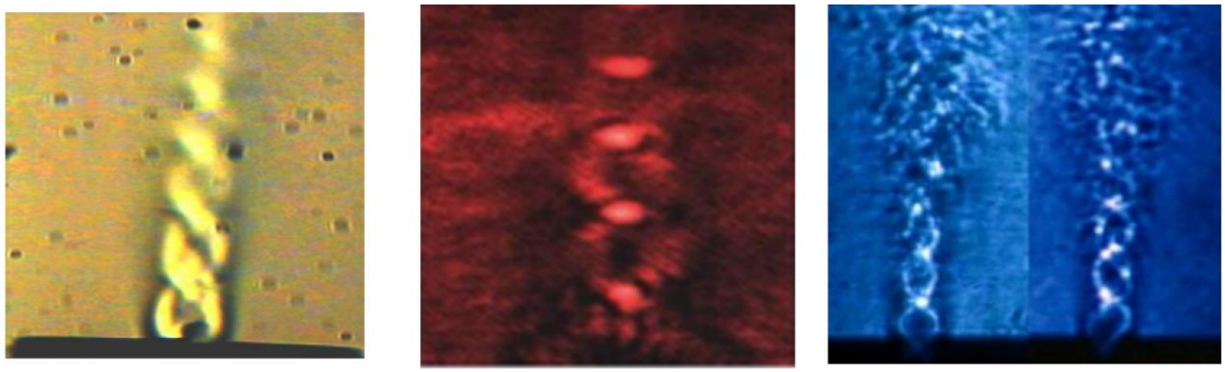

Figure 2.
Visualization of plasma-dust jets using various technical means. a) Schlieren Photography of the spiral structure of a plasma-dust jet [12]; b) Laser visualization of a spiral jet with a different emitter tuning [27]; c) Visualization by ultraviolet laser of spiral jets under different emitter tunings [12].

The configuration of the jet is determined by the nature of the functioning of the emitter, which is absent in the cases of DNA double helices and cosmic nebula [9]. Upon closer examination, it turns out that the double helix of such a jet consists of two spirals separated from each other: there are significant gaps between them in some areas, but at the nodes of the double helix they collide with each other, which is accompanied by intermolecular and interatomic inelastic collisions with super accelerations (for example, for oxygen molecules the magnitude of this acceleration is proportional to 10^{14} m/sec^2, and for hydrogen molecules it is proportional 10^{16} m/sec^2) [13].

The shape of the double spirally curled jet allows it to be classified as a supersonic plasma-dust crystal, that is, structurally ordered types of dust plasma. Its self-compressive shape causes an increase in speed along the jet, since the same volume of plasma passes through its successively decreasing cross-section. Accordingly, as the jet moves, the frequency of ultrasonic vibrations in it changes. Ejective suction of air from the atmosphere into a supersonic jet can further increase its kinetic energy. The plasma temperature along the jet, measured by a thermal imager, ranged from 263^{0}K to 280^{0}K. The temperature of the atmosphere in the vicinity of the flow flowing out of the nozzle is equal to 253^{0}K—258°K.

3. Experiments

3.1. Impact of Spiral Jets of Dusty Plasma on Burning Coal

In these experiments, 5 pieces of burning coal of arbitrary shape weighing 1 kg each were placed on a cast-iron grate of a heating furnace. These pieces of coal as targets were exposed for 60 minutes simultaneously and from different sides by 12 plasma-dust jets from 12 emitters from a distance of 10-15 cm: 8 jets were directed from below onto these pieces of coal, and 4 other jets were directed from four sides.

When plasma jets were applied to pieces of coal, a sharp change in the initial pattern of chemical combustion of coal was immediately observed: powerful radiation of light and thermal energy occurred without the release of particles of black soot and smoke, which are characteristic of chemical combustion of coal and which contain oxides of carbon and nitrogen. At the same time, instead of black smoke, the coals emitted many brightly luminous particles into the surrounding atmosphere, which, as subsequent chemical analysis showed, consisted of 90-95% silicon oxides. Figure 3 shows how the pattern of chemical combustion of coal changes when a plasma-dust spiral jet is supplied to this coal from the emitter.

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a b c d

Figure 3.
Comparative pictures of the processes of heat and light emission from coal. a) ordinary chemical combustion of coal; b) when exposed to spiral plasma jets from 12 dynamic emitters on coal, powerful radiation of high-energy photons and the emission of luminous particles is observed; c) the same thing, but when exposed to a jet from one dynamic emitter; d) luminous particles flying out of the pipe of a heating furnace when burning coal is exposed to a single plasma jet.

When the cessation of the impact of the jets, a gradual covering of the coal pieces with a thin shell of gray ash was observed. After the coal was naturally cooled for at least 60 minutes, the ash shell was removed by the experimenter from each piece and under it, not coal was found, but a single mineral of a white-cream hue. Its chemical analysis showed that it is an aluminosilicate containing the following main components in percentage: SiO_2 - 82,92% , Al_2O_3 – 11, 24%, Fe_2O_3 - 1,50%. Thus, coal turned into aluminosilicate. At the same time, the original coal contains practically no silicon oxide [25]. The chemical composition of coal ash is presented in the work [26]. Changing the mode of exposure to plasma-dust jets allows you to influence the percentage composition of the final mineral. This experimental example demonstrates the possibility of using this phenomenon to obtain large-sized solid aluminosilicates from the coal mineral. Figure 4 illustrates such transformation as a result of the action of spiral plasma-dust jets.

a b

Figure 4.
Transformation of coal into an aluminosilicate mineral: a) the original piece of coal; c) the final piece of aluminosilicate obtained as a result of plasma-dust exposure.

3.2. Impact of Spiral Dust Plasma Jets on a Propane Flame

A plasma-dust air jet from a dynamic emitter under a pressure of 4-6 bar at an ambient temperature of 293⁰K and air humidity of 66% was directed onto the flame of burning propane. At the moment of the beginning of the impact of this jet on the flame, powerful light radiation began in the violet, ultraviolet and x-ray ranges [27, 28]. At the same time, there was no formation of carbon monoxide, characteristic of the chemical combustion of propane. The spectral composition of light radiation is constantly changing at high speed, although the conditions for supplying the plasma jet and propane are fixed (Fig. 5).

Figure 5.
Illustration of changes in the spectral composition of light radiation in an experiment with propane in a stationary mode.

This feature of light radiation is not typical for chemical combustion.
The results described above were confirmed by repeating the experiments many times.

4. Summary and Conclusion

Experiments on the impact of a supersonic spiral plasma-dust jet into the combustion zone of natural coolants - coal, methane, propane, etc. - revealed the following features of the discovered phenomenon of the transformation of their oxidative combustion into the production of powerful light and thermal energy. There is no formation of harmful waste gaseous oxides of carbon and nitrogen, as well as soot, which are characteristic of the oxidative chemical combustion of these coolants. The process of releasing the said energy for each type of initial coolant may have its own specifics. For example, the impact of plasma-dust jets on a coal combustion zone is accompanied by the release into the atmosphere of an abundance of luminous particles of silicon oxides and, with prolonged exposure, can lead to the formation of aluminosilicate minerals from coal. The supply of the same jets in a stationary mode to the propane combustion zone is accompanied by a continuous significant change in the spectral composition of light radiation.

The discovered phenomenon of powerful thermal and light radiation under the indicated plasma-dust effects without the release of greenhouse gases, which are characteristic of the oxidative combustion of coal minerals and natural hydrocarbons, can be considered as a possibility of fundamentally replacing by them traditional chemical combustion in industry and other sectors. Replacing the chemical combustion of natural coolants with the described phenomenon can contribute to the fight against the greenhouse effect and global warming of the Earth's atmosphere.

The results obtained should also be taken into account when understanding the known fact of the predominance of aluminosilicate minerals in the earth's crust and cosmic dust.

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