Biofuel productuin from sunflower husk

O S Anisimova\textsuperscript{1} and V A Kolomytsa\textsuperscript{2}

\textsuperscript{1}Donskoy State Agrarian University, 346493, Southern Federal District, Rostov Region, Oktaybrsky District, Persianovsky, 24 Krivoshlykova st., Russia
\textsuperscript{2}Novocherkassk Engineering and Reclamation Institute n.a. A.K. Kortunov, Donskoy SAU, 346428, Novocherkassk, 111 Pushkinskaya st., Russia

E-mail: vkolomytsa@mail.ru

Abstract. At the oil and fat production enterprises, a large amount of sunflower husk is production waste. It is a valuable raw material that allows enterprises to receive additional profit by implementing innovative biofuel production. The objectives of the study are to identify the areas of use of biofuel from sunflower husk and to determine the technological and economic advantages of biofuel production from sunflower husk. The economic efficiency of the production of pellets from sunflower husks is described. There is a growing demand for this type of fuel. Therefore, it is not difficult to find a sales market for this type of fuel. The biofuel production from sunflower husks will allow processing enterprises to receive additional profit, reduce the area for storing sunflower processing waste, improve the environmental situation on the territory of the enterprise and in the surrounding area. Recommendations for the implementation of waste processing technology at the fat and oil industry enterprises are provided.

1. Introduction

At oil and fat production enterprises, a large amount of sunflower husk is production waste. It is necessary to identify areas of use of biofuels from sunflower husks. Some enterprises give it away free of charge. Others sell it at 100-200 rubles per ton. This production waste is a valuable raw material that allows enterprises to receive additional profit [1].

The research tasks are:
- to identify areas of use of biofuel from sunflower husk;
- to determine technological and economic advantages of biofuel from sunflower husk at the enterprises of the oil and fat industry;
- to give recommendations on the implementation of waste processing technology at the enterprises of the oil and fat industry.

The aim of the work was to study the advantages of innovative technologies for the production of biofuel from sunflower husks - fuel briquettes and pellets.

2. Results and discussion

Fuel briquettes and pellets (Figure 1) from sunflower husks are environmentally friendly fuel without binders. They are used as fuel for fireplaces, baths, saunas, household stoves, boilers, etc.
When burning fuel from sunflower husks, the resulting flame is without sparks. Carbon dioxide is emitted in negligible amounts. The briquette burns almost completely, forming 0.9% ash.

Table 1 compares classic fuel and fuel briquettes by CO$_2$ content (emitted into the air during combustion) [2,3].

| Fuel                  | CO$_2$ content in combustion products |
|-----------------------|---------------------------------------|
| fuel briquettes       | 1                                     |
| Natural gas           | 15                                    |
| Fuel oil              | 20                                    |
| coke                  | 30                                    |
| Coal                  | 50                                    |

The technology for the production of fuel briquettes and pellets is based on the process of pressing sunflower husks, finely crushed wood waste, etc. under high pressure when heated from 250 to 350$^\circ$C. The resulting fuel briquettes do not contain any binders, except for lignin contained in the cells of plant waste. The pressing temperature contributes to the melting of the briquette surface, which thereby becomes more durable [1, 4, 5].

The calorific value of the briquette is close to the coal’s one. Table 2 compares sawdust and sunflower husk briquettes with coal.

| Parameters                  | Briquette components | Coal            |
|-----------------------------|----------------------|-----------------|
|                            | sawdust | husk            |                 |
| Density, t/m$^3$            | 1,1     | 0,9 - 1,2       | 1,2 - 1,5       |
| Calorific value, kcal / kg | 4000 - 4800         | 4800 - 5200     | 4400 - 5200     |
| Ash content, %              | 0,5 - 1,0           | 0,35 - 3,0      | 10 - 20         |

Table 2 shows that the caloric value of briquettes is similar to the coal’s one, and the ash content is ten times lower in briquettes. In addition, the burning of briquettes does not generate sulfur emissions, which makes them an environmentally friendly product [6, 7,8].

According to the European classification, such briquettes are a fuel that does not generate smoke, therefore they are suitable for cooking any food in barbecues and grills. Since carbon monoxide is not emitted during the combustion of briquettes, cooking can be done indoors. This type of fuel is also suitable for fireplaces and heating equipment installed inside the house. They are very compact. This is of great importance when using them for heating country houses. Among other things, small-sized fuel is very convenient to transport, it is easy to load and unload.
In Russia, fuel briquettes and pellets can be sold to various utilities and agricultural enterprises, educational institutions, etc. Almost any enterprise needs solid fuel for heating. A positive factor of biofuel production is the re-equipment of the area of municipal boiler houses for this type of fuel [9, 10].

The main type of equipment for the production of briquettes is a press. An analysis of the market showed that the PBE-150 press extruder is more suitable (Figure 2).

The PBE-150 is designed for the production of fuel briquettes from food and forestry waste, i.e. from sunflower husks, buckwheat husks, rice and other cereals, and sawdust [11].

Figure 2. PBE-150 Press extruder

The advantages of this press are:
- low energy consumption;
- high performance;
- ease of maintenance;
- mobility during installation;
- reliability in operation and quick recovery of the working auger.

PBE-150 can be operated in a room with an ambient temperature of at least +5 °C, with the ventilation and smoke extraction equipment. This extruder produces fuel briquettes in the form of a 6-sided bar with a hole with a diameter of 20 mm to remove the smoke generated during the briquetting process. The bar is cut to the required dimensions with a side saw. The briquettes are packed in shrink film or cardboard containers weighing 9-12 kg. The briquette has a diameter of 50 mm, along the edges - 55 mm, which corresponds to the European standard [9, 11-13].

Table 3. The main parameters of raw materials used for the production of briquettes

| Parameters                          | Raw materials |
|-------------------------------------|---------------|
|                                     | Saw dust      | husk          |
| Moisture, %                         | 6 - 7         | 4 - 7         |
| Temperature, °C                     | 300 - 350     | 200 - 280     |
| Fraction of particles of raw materials, mm | Up to 8      | 2 - 8         |
| Productivity, kg / hour             | 130 - 180     | 120 - 160     |

The main technical characteristics of the PBE-150:
- power consumption - 12 - 15 kW/h;
- height - 1300 mm;
In addition to the press, the following equipment is required for the production process:
- a ventilation and smoke extraction device;
- a drying system with a solid fuel heat generator;
- a conveyor;
- a Remote Control;
- a packing machine;

The production line plan assumes the presence of utility rooms and warehouses in the production area; the area of premises must be at least 70 m².

For the production of pellets, you can use small biomass pelletizing lines (Czech Republic) with the following characteristics.

**Line models:** MGL 100 / MGL 200 / MGL 400 / MGL 600 / MGL 800.

**Productivity, kg/hour:** 50 - 100/50 - 200/150 - 350/200 - 500/450 - 1000.

**Power consumption, kW/hour:** 6 / 8.85 / 19/26/30.

**Occupied area, m²:** 2/4/8/8/8.

**Weight, kg:** 180/430/580/845/950.

The MGL 200 / MGL 400 / MGL 600 / MGL 800 lines include the following equipment:

1. A raw material hopper with an auger feed and a patented dosing mechanism.
2. A mixer with a device for moistening mixture.
3. A granulating press.
4. A device for cooling and sorting granules.
5. An energy distributor (control panel) + air extraction system.

The MGL 100 line includes:

1. A hopper for raw materials with a granulating press.
2. A device for moistening the mixture.
3. A device for sorting granules.

An analysis of recurrent costs shows that these include:
- raw materials costs;
- electricity costs;
- salary costs;
- depreciation deductions.

The results of calculation of the economic efficiency of biofuel production from sunflower husk are shown in Table 4.

**Table 4. Economic efficiency of the production of pellets from sunflower husk**

| Parameters                               | Value, thousand rubles / month |
|------------------------------------------|--------------------------------|
| Equipment cost                           | 696                            |
| Cost of 1 ton of pellets                 | 4                              |
| Gross monthly income                     | 200                            |
| Monthly expenses:                        |                                |
| - cost of raw materials                  | 100                            |
| - electricity costs                      | 16                             |
| - wages                                  | 60                             |
| - depreciation and wear of equipment     | 5,8                            |
| Total:                                   | 182                            |
| Gross profit                             | 18                             |
| Gross profitability, %                   | 9                              |
| Payback period                           | 38,7 months = 3,2 years        |
3. Conclusion

Thus, fuel briquettes and pellets have a number of advantages. They have a high caloric value, burn for a long time, emit less ash and CO$_2$, do not get dirty; they are convenient for storing and transporting.

Biofuels is produced from production waste and do not require raw materials and consumables. The production does not require a large number of maintenance staff.

It is recommended to purchase appropriate equipment and organize the production of fuel briquettes or pellets from this waste.

There is a growing demand for this type of fuel. Therefore, it will not be difficult to find a sales market for this type of fuel.

The biofuel production from sunflower husk will allow processing enterprises to receive additional profit, reduce the area for storing sunflower processing waste, improve the environmental situation on the territory of the enterprise and in the surrounding area.

References

[1] Tkachenko I V 2014 Innovative technologies for optimizing agricultural production taking into account the influence of random factors (NIMI DGAU. - Novocherkassk: Lik)

[2] Kirilenko S G and Khanin V P 2019 Features of the production of fuel pellets from the husk of sunflower seeds Prospects for the development of the food and chemical industry in modern conditions. Materials of the All-Russian Scientific and Practical Conference dedicated to the 45th anniversary of the Faculty of Applied Biotechnology and Engineering of Orenburg State University, 493.

[3] Ladygin E A, Avdeenko I A and Sergeev A V 2016 Review of modern presses for the production of fuel pellets and briquettes Use of modern technologies in agriculture and food industry materials of the international scientific-practical conference of students, graduate students and young scientists, 453.

[4] Melnichuk M M and Prutinskaya E A 2019 Development of integrated processing of sunflower husk Self-developing environment of a technical university: research and experimental development. Materials of the IV All-Russian Scientific and Practical Conference, 223.

[5] Tkachenko V A 2007 Development of an integrated system of energy supply for agricultural farms based on cogeneration and biogas technologies Bulletin of the Kamchatka State Technical University 6 96-98

[6] Mkhitaryan N M 1999 Energy of unconventional and renewable sources. Experience and prospects (Kiev: Naukova Dumka)

[7] Sosin D V, Litun D S, Ryzhiy I A, Shtegman A V and Shaposhnikov N A 2020 Experience of burning sunflower husks in pulverized coal boilers of the Kumertau CHP Heat energy 98

[8] Sapyan Yu N, Uuyotov S Yu, Ovchinnikov E V and Kostomakhin M N 2019 Production of renewable fuels in the world Agricultural machinery: maintenance and repair 12 85

[9] Nazarov V I, Bulatov I A and Makarenkov D A 2009 Features of the development of the process of press granulation of biofuel based on wood and plant waste Chemical and Oil and Gas Engineering 2 50

[10] Quispeab I Naviabcd R and Kahhata R 2017 Energy potential from rice husk through direct combustion and fast pyrolysis Waste Management 59 2000-2010

[11] Shayakhmetova A Kh, Timerbaeva A L and Borisova R V 2015 Comparative characteristics of pellets from sunflower husk and wood pellets Bulletin of Kazan Technological university 18(2) 453

[12] Titova E, Bondarchuk N and Romanova E 2017 Economic aspects of the cultivation of some plants used as raw materials in the production of biofuel International Agricultural Journal 1 259

[13] Shayakhmetova A Kh 2015 Comparative analysis of the characteristics of alternative types of solid biofuels Bulletin of Kazan Technological university 18(2) 453