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Maintenance of Physical and Mechanical Properties of Cotton Fiber During Storage of Raw Cotton

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ABSTRACT

This article provides materials on the effectiveness of drying raw cotton during the post-harvest period to ensure its safety. Existing systems of primary processing of raw cotton incorporate energy-intensive technological processes. In connection with these problems, it is becoming increasingly necessary to use solar energy, along with the introduction of energy-saving technologies. The article discusses the feasibility of using a solar drying unit for drying raw cotton, which can be installed in cotton harvesting stations and at enterprises of primary cotton processing. Also, materials are presented on preserving the basic physical and mechanical properties of cotton fiber — length, linear density, elasticity, crimp, breaking length and other indicators that are of great importance for yarn production, since the more uniform the fiber, the easier it is to make a uniform yarn from them.

Key words: Raw cotton, Primary processing, Storage, Warehousing, Fuel, Solar energy, Collector, Dryer.

1. INTRODUCTION

Cotton fiber is one of the most important strategic goods in world trade. According to the International Cotton Advisory Committee (ICAC), global production of the cotton fiber is recovering now after the global financial crisis of 2007-2009 [1].

Cotton complex occupies central place in the economy of Republic of Uzbekistan. The reforms implemented by the government in the cotton industry were an essential element in the systematic development of the country and its transition to a market economy. The main production of the complex - cotton fiber - is a competitive technical product on the world market. Incomes from the sale of fiber on the international market are important items of foreign exchange proceeds to the budget of Republic of Uzbekistan [2].

Republic of Uzbekistan today is the sixth largest producer of cotton fiber with production volume of about 1 million tons. It should be mentioned that the leading positions of the China, Brazil and Australia are based on high cotton capacity, which is more than two to three times higher than the indicators of Republic of Uzbekistan and USA. In increasing cotton productivity, large reserves are hidden to increase cotton production in our republic [3].

2. MATERIALS AND METHODS

Annually around the world, about 20 million tons of raw cotton is produced. The result is about 6.5-7% million tons of produced cotton fiber. Processing takes 8-10 months a year. The qualitative and quantitative indicators of the produced cotton fiber and other waste products largely depend on level of development of machinery and technology for the primary processing of raw cotton, including the processes of preparing the material for the ginning operation [4].

The length, fineness, strength, elasticity, crimp, breaking length, maturity and fiber yield, determines the technological properties of cotton fiber.

The physical and mechanical properties of cotton fiber include linear density (thickness), length, strength, elongation and elasticity, resistance to abrasion, bending, compression, torsion and sliding of the fiber along the fiber, hygroscopicity, color, electrical and thermal conductivity.

Linear density is one of the most important properties of fiber. This value shows how much mass has fiber of a certain length.

The linear density of the fibers is very important. The strength of yarn made from fibers depends on the strength of the fibers and on friction forces between them. Moreover, these forces will be greater, the more contacts between the fibers in its cross section, which in turn depends on the number of fibers. Therefore, the finer the fiber, i.e., the lower their linear density, the greater number of them will be in the cross section of a given yarn and the stronger the yarn will be. On the other hand, the finer the fiber, the thinner yarn with normal strength can be obtained from them [5].

Fiber length is also a very important characteristic of cotton, which determines its quality. The longer the fiber, the more it encounters other fibers in the yarn and the more difficult it is to pull them apart [6]. Therefore, from long fibers it is possible to obtain stronger yarn of the same linear density, or, on the other hand, from longer fibers it is possible to obtain thinner yarn with normal strength.

Fiber strength is its ability to withstand tensile forces. To assess the strength, they use the value of the breaking load, i.e., the greatest force held by the fiber before breaking [7].

Uniformity of the fibers is of great importance for the production of yarn, since the more uniform the fibers, the easier it is to produce uniform yarn from them, which in turn largely determines the productivity of the processes of its processing and the quality of the produced fabrics [8].

Important properties of the fibers are also elongation and elasticity. When tensile forces are applied to the fiber, it lengthens, i.e., it receives deformation.

Hygroscopicity is the property of a material to change its moisture content depending on humidity and ambient temperature. Fibers contain a certain amount of moisture. With increasing air humidity or increasing its temperature, the humidity of the fibers increases, and vice versa. If a fiber has this property, then it is hygroscopic. This remarkable property of fibers largely determines the hygienic and operational properties of fabrics [9].

3. RESULTS AND DISCUSSION

Cotton fiber in dry condition has a low electrical conductivity, which allows using of cotton fabrics as isolation material. Electrical conductivity increases with increasing humidity. Electrostatic charges occur during mechanical impacts on cotton, which make it difficult to process [10].

In modern conditions, the basis of competitiveness is to reduce energy intensity and improve product quality. Today, customers often make clearly exaggerated demands on quality in order to bring down the price of products, playing on fierce competition between its manufacturers.

The ginning enterprises during the harvesting period cannot always process all incoming cotton at once. Part of the raw cotton is dried and placed in bundles, in which the cotton is stored until it reaches the ginneries. Therefore, high-quality storage and processing of raw cotton are the main factors in production.

To obtain a more efficient and high-quality fiber during processing raw cotton, their moisture content should be in the range of 8-9%. Usually, the first grade of raw cotton has 9-11% moisture. Therefore, it is necessary to reduce the moisture content of raw cotton to 8-9% before ginning.

Drying of raw cotton is usually carried out using a heat generator. Solid or liquid fuel is burned in the heat generator, the exhaust gases enter the air heater, where the air supplied by the air-handling unit is heated, which then enters the dryer cylinder. Inside the cylinder, with the help of the shoulder blades, the cotton is mixed, while it is blown with hot air and dried. The air temperature at the inlet to the cylinder is maintained at 300 °C and at the outlet at 100 °C. Usually, one heat generator serves several drying cylinders [11].

The dryer with gas burners of infrared radiation consists of two screw conveyors interconnected by loading belts. The length of each conveyor belt is 20 m, above the tapes along their entire length; infrared burners with total heat output of 115 thousand kcal/h over one screw and 80 thousand kcal/h over another screw are installed. Burners are mounted on suspended frames for unit at effective height. The entire dryer is installed under the shed.

The load intensity, gear pulleys and a change in the speed can control the performance of the dryer. Infrared rays penetrate the cotton layer to a shallow depth; therefore it must be mixed to ensure uniform heating of the raw cotton. For mixing, blades and shelves are welded onto the screw of the screw.

The maximum temperature of cotton at the exit from the conveyor should not exceed 45-50 °C, heating of cotton above 50 °C leads to deterioration in its quality [12].

Drying of raw cotton can also be carried out on a conveyor belt with radiating burners installed above it. To achieve uniform drying, the cotton layer is mixed with spatula agitators installed at regular intervals on the conveyor belt. The conveyor belt can be perforated or made of metal mesh.

Drying of raw cotton during post-harvest processing is the most effective means of ensuring its safety. Currently used methods of drying raw cotton due to the introduction of automatic tools and systems and the use of progressive modes provide high performance drying equipment and the required quality indicators of raw cotton [13]. At the same time, the existing systems of primary processing of raw cotton incorporate energy-intensive technological processes. A sharp increase in energy prices has set the task of rational use of primary cotton processing units. The high-energy intensity of the drying units, considerable expenditures of energy fuel and electricity – all this creates the prerequisites for developing a way to increase the energy efficiency of the primary processing of raw cotton.

Formation of power engineering occurred several million years ago when people learned how to use fire. Fire gave them warmth and light, was a source of inspiration and optimism, a weapon against enemies and wild animals, a therapeutic agent, an assistant in agriculture, a food preservative, a technological tool, etc.

For many years, the fire was maintained by burning plant energy (wood, shrubs, reeds, grass, dry algae, etc.), and then it was discovered that it was possible to use fossil substances for maintaining fire: coal, oil, shale, peat.

Now we know that wood is solar energy accumulated through photosynthesis. About 20000 kJ of heat is released when each kilogram of dry wood is burned; the calorific value of brown coal is approximately 13000 kJ/kg, of anthracite 25000 kJ /

kg, oil and of petroleum products 42000 kJ/kg, and natural gas 45000 kJ/kg. The highest calorific value is possessed by hydrogen of 120000 kJ/kg [14].

Humanity needs energy, and its needs are increasing every year. At the same time, the reserves of traditional natural fuels (oil, coal, gas, etc.) are finite. The reserves of nuclear fuel – uranium and thorium, from which plutonium can be obtained – are also finite. The inexhaustible reserves of thermonuclear fuel – hydrogen – are practically inexhaustible, but controlled thermonuclear reactions have not yet been mastered, and it is not known when they will be used for industrial production of energy in its pure form, i.e., without the participation of fission reactors in this process. In connection with these problems, it is becoming increasingly necessary to use non-traditional energy resources, primarily solar, wind, geothermal energy, along with the introduction of energy-saving technologies.

Solar radiation is the most promising among renewable energy sources, in terms of resources, environmental cleanliness and ubiquity.

Renewable energy sources allow replacing energy fuels in thermal processes. The most promising source here may be solar energy. Raw cotton growing areas have a high solar energy potential, with an average of 2000 hours of sunshine in them.

The work proposed by scientists considers the feasibility of using a solar drying plant as an additional unit for drying grain, which can be installed in cotton harvesting centers and in primary processing plants for raw cotton for drying raw cotton. This combination of equipment will avoid the cost of energy fuel, which makes a solar drying plant economically advantageous for a number of units operating on diesel fuel, natural gas, liquefied gas, where fuel costs are about 20% of total costs. The operation of the unit on solar energy makes it safe for the environment. It is quite reliable and practically does not require maintenance compared to existing drying units, in which maintenance costs reach 11% of the total. The greatest effect in this unit is the facilitated and not time-consuming process of preparing raw cotton for long-term storage, this allows the transfer of raw cotton on long-term storage bundles with minimal losses, while the quality of raw cotton is significantly improved, which leads to an increase prices for this type of product.

Convective drying is used in ginneries to dry raw cotton, which is carried out mainly in cylinder types of dryers. All existing cotton-drying aggregates have a high-energy intensity (high costs of thermal and electric energy), as evidenced by their technical characteristics [15].

The existing foreign experience in the use of solar units for thermal technological processes is quite wide and can be used to create combined energy supply systems for agricultural production. Combined systems based on solar heating systems can increase the drying process energy efficiency by 1.2–1.3 times.

Currently, energy saving is one of the priority tasks. This is connected with the shortage of basic energy resources, the increasing cost of their production, as well as global environmental problems [16].

Energy saving is the efficient use of energy resources through the use of innovative solutions that are technically feasible, economically justified, environmentally and socially acceptable, and do not change the usual way of life.

Proper organization of the drying and cleaning of raw cotton is important in order to ensure maintenance of natural properties of raw cotton and its high-quality processing, to obtain the proper quality of cotton fiber, seeds and lint.

Harvesting of raw cotton lasts relatively short (1.5-2.5 months), while about 25% of the harvested raw cotton is processed at the ginneries during the harvesting season. The bulk of raw cotton is stored in bundles and covered warehouses for long-term storage for processing throughout the year until new harvest.

Not only the maintenance of natural properties, but also the qualities of the resulting fiber, seeds and, to a large extent, the economic performance of the cotton enterprise depend on the proper storage of raw cotton [17]. The very warming of cotton, as well as the mixing of various batches of raw materials, must not be allowed. Self-heating of raw cotton, arising due to high humidity caused by untimely and poor-quality drying and cleaning of weed impurities, leads not only to a decrease in fiber yield, but also to damage to fiber and seeds.

Nowadays, in conditions of market economy, the production of competitive products is urgent task for industrial enterprises. Therefore, research is underway to modernize, design and use equipment and technology with minimal energy costs at cotton processing enterprises in order to preserve the natural properties of cotton fiber [18].

For mechanization of labor-intensive operations involving raw cotton loading of closed storages and bundle sites at non-factory and factory harvesting stations, PTX-20 mobile receiving and supplying devices and PLA belt feeder, working in combination with mobile conveyor belts TXL-15, TXL-18 or TL are used.

The PLA belt feeder (Fig. 1) is designed to receive raw cotton transported without containers in transport trailers and cotton carriers, and then feed it to the conveyor belt. It consists of horizontal conveyor, drive cylinder, gearbox, lower cylinder, bucket elevator, upper cylinder, mounted gearbox, cabinet for electrical equipment, and tension cylinder of horizontal conveyor [19].

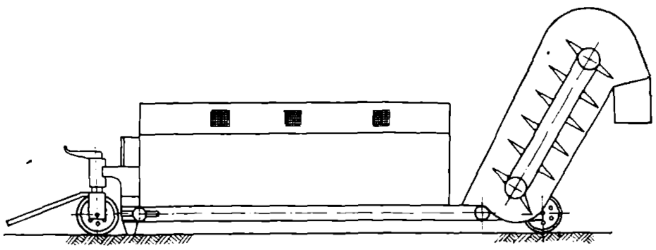

Figure 1: PLA belt feeder

The unloading of body of tractor-trailer fed to the wall of the feeder takes place in two stages - half the volume for each. The raw cotton unloaded from the trailer onto the conveyor belt moves to the feeder elevator, is picked up by its bunkers, lifted and dumped into the receiving funnel of the TXL-18 conveyor belt, which is then fed to the bundle (or covered storage) [20].

For mechanization of labor-intensive operations involving raw cotton loading of closed storages and bundle sites at non-factory and factory harvesting stations, PTX-20 mobile receiving and supplying devices and PLA belt feeder, working in combination with mobile conveyor belts TXL-15, TXL-18 or TL are used.

Bunker feeder elevator consists of the upper and lower cylinders, which are turned by a conveyor belt with bunker batten. The gear mounted on the shaft of the upper cylinder and connected to electric motor drives the cylinders.

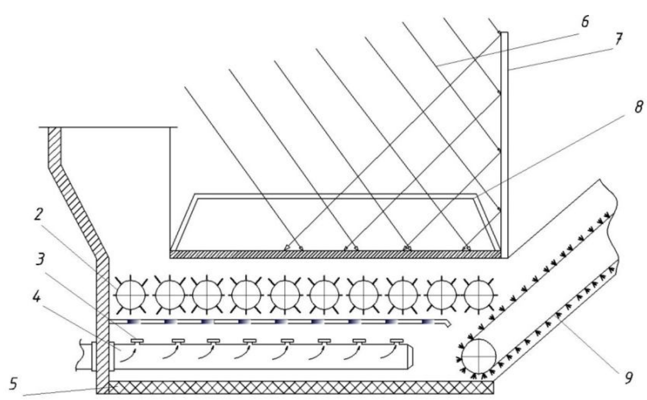

Figure 2: Unit scheme for drying and feeding raw cotton for storage

1 - bunker feeder; 2 - bunker cylinders; 3 - mesh surface; 4 - pipe of hot air; 5 - isolating chamber; 6 - solar radiation; 7 - concentrator of solar radiation; 8 - translucent coating (tempered glass); 9 - elevator.

We have developed and proposed new design of raw cotton feeding unit for storage based on a PLA feeder in order to preserve the natural properties of raw cotton during storage

Unit for drying and feeding raw cotton for storage under consideration is a complex of devices, which includes(Fig. 2): bunker-feeder 1, ring cylinders 2, mesh surface 3, hot air pipe 4, isolating chamber 5, solar radiation 6, solar concentrator 7, translucent coating (tempered glass) 8 and elevator 9.

The bunker feeder 1 should provide the necessary unit performance and evenly distribute the raw cotton across the width of the ring cylinders. The unit is 2 meters wide and 8 meters long. Raw cylinders are loosened by raw cotton in such a way that it will allow primary drying of 150-160 kilograms of raw cotton in 1 minute. This allows drying more than 70-80 tons of raw cotton in 8 hours on a sunny day.

Equipment for drying and feeding raw cotton for warehousing works as follows. Clean air is sucked in by fan at height of about 2 m and fed into the airborne solar panel, where it heats up due to solar radiation to a temperature of 900-100 °C, at this temperature, raw cotton will not lose its properties. Next, the heated air passes into the dryer itself, where, flowing through the mesh surface, it circulates in the upper part of the dryer, taking moisture from the raw cotton and preventing it from condensing due to secondary heating from solar radiation. Air saturated with moisture is removed from the hole located near the bunker-feeder. The proposed design of the equipment for drying and feeding raw cotton can also be used for other types of bulk materials [21].

In order to increase the drying efficiency of raw cotton, air solar thermal collector is also additionally provided in the design of the raw cotton supply for storage unit. The functional diagram of the solar thermal collector is shown in Fig. 3. The solar thermal collector consists of gas-air, water-air or electric-air calorifero, fan unit, translucent coating, and thermal isolation.

Solar thermal collector is a cylindrical structure with thermal isolation from below, translucent coating from above and absorbing element between them. Thermal insulation (polystyrene, mineral wool) with a thickness of 50-100 mm and thermal conductivity <0.5, is laid in the lower part of the housing and is covered with a reflective coating.

Black metal shavings are used as absorbing element, since it has high heat transfer and high degree of blackness, in addition, there are a large number of air gaps in the shavings layer through which air passes through heating. Metal mesh is used to fix and evenly distribute the chips in the solar collector.

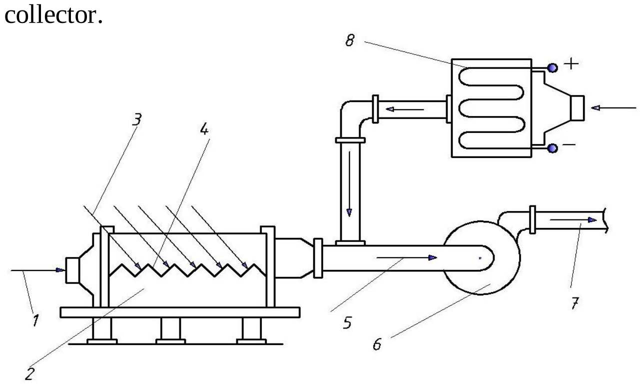

Figure 3: Functional scheme of the air solar collector

1 - Atmospheric air; 2 - solar collector; 3 - sunbeam; 4 - absorber (beam absorber); 5 - heated atmospheric air; 6 - fan; 7 - pipe for hot air; 8 - calorifero.

Air solar thermal collector operates as follows. Solar short-wave electromagnetic radiation with almost no loss (up to 5%) passes through the translucent upper cover of the collector and enters the absorbing element (metal shavings). In turn, in the absorbing element, solar energy is converted into long-wave electromagnetic radiation in the infrared spectrum, for which the upper transparent coating becomes non-transparent. The air flowing along the absorbent element in which the air is heated and fed to the raw cotton plant using a fan to storage.

In cases where there is no solar energy, a flap valve is provided in the design (Fig. 3), which blocks the air duct from the solar heat collector and opens the air duct from an alternative air heater, in which the air is heated and fed to the raw cotton plant using a fan to storage.

The heat power supplied to the drying unities determined by the expression:

$$Q_{подв} = \eta_{mn} \left[\eta_{опт} \cdot q_{пад} - k_{пр} \left(\bar{t}_f - \bar{t}_o \right) \right] F_{фр}, \qquad (1)$$

Where η_{mn} – efficiency coefficient of heat absorber of the solar collector;

$\eta_{опт}$ – Efficiency coefficient of absorption of solar radiation by the surface of cameras;

$q_{пад}$ – Flux density of incident radiation to the front surface of chambers;

$k_{пр}$ – Coefficient of total heat losses of collector reduced per unit of beam-absorbing surface;

$\bar{t}_f$ – Average temperature of heat-carrying agent along the length of chambers;

$\bar{t}_o$ – Average temperature of heat-carrying agent in heat removal channel;

$F_{фр}$ – Area of front beam-absorbing surface of chambers

On the other hand, this thermal power is equal to

$$Q_{подв} = G_в c_в (t_1 - t_0), \qquad (2)$$

Where $G_в$ и $c_в$ – respectively, the flow rate and specific heat capacity of the drying agent;

t_1 – Air temperature heated by solar radiation;

t_0 – Ambient temperature;

Heat power generated in the solar collector, in turn, is spent on the evaporation of moisture from the dried product in the $Q_{пол}$ unit to compensate heat loss through the walls of Q_{mn} chamber and is carried away with the spent drying agent's $Q_{сб}$, i.e.

$$Q_{подв} = Q_{пол} + Q_{mn} + Q_{сб} \qquad (3)$$

The values of the terms are determined from the corresponding expressions:

$$Q_{пол} = G_{вл} \cdot r \qquad (4)$$

$$Q_{mn} = \sum k_i \cdot F_i (t_k - t_0) \qquad (5)$$

$$Q_{сб} = G_в \cdot c_в (t_2 - t_0) \qquad (6)$$

Where $G_{вл}$ – the intensity of the evaporated moisture from the product;

r – Latent heat of vaporization;

k_i and F_i – accordingly, the coefficient of heat loss and the heat transfer surface of the itch chamber wall;

t_k – Average temperature of heat-carrying agent along length of chamber;

t_2 – Average temperature of heat-carrying agent spent.

4. CONCLUSIONS

Thereby, it is necessary to comply with all the above rules for the storage and processing of raw cotton using modern equipment and technology in order to ensure the production of high quality yarn. These allow obtaining the most diverse yarn from cotton fibers: from thick to produce coarse and various furniture and clothing fabrics to very fine, from which thin elegant fabrics are produced.

REFERENCES

[1] Hvala A., Anger. V., **Textile excipients**, Part I, Translated from German M.: Legprom publication, (1991), 448 p.

[2] Juraev Anvar and Rajabov Ozod, **Analysis of the interaction of Fibrous Material with a Multifaceted Grid of the cleaner**, International Journal of Recent Technology and Engineering, vol. 8, No 1, (2019), pp. 2661-2666.

[3] Djuraev Anvar and Kuliev Tokhir Mamarajapovich, **Designing and Methods of Calculating Parameters of a Fibrous Material Cleaner From Large Litter**, International Journal of Advanced Science and Technology, Vol. 29, No. 8s, (2020), pp. 444-452.

[4] O. I. Rajabov, A. S. Abrorov, N. I. Mirzaqulova, G. B. Zaripov, Kh. S. Ziyodullaev, **An experimental study of the location of the grid bars cells installed under spiked cylinders in a cotton cleaner from small waste**, IOP Conference Series: Materials Science and Engineering, (2020), 734(1) 012073.

[5] O.I. Rajabov, F.A.Fazliddin, M. H. Gapparova and J. Shakhrillo, **The influence of the location of the cells on the allocation of weed impurities for cleaning raw cotton from fine waste**, IOP Conference Series: Materials Science and Engineering, (2020), 734(1) 012073.

[6] Murodov O, **Perfection of designs and rationale of**

parameters of plastic koloski cleaning cleaners, International Journal of Innovative Technology and Exploring Engineering, vol. 8, No 12, (2019), pp. 26401-2646.

[7] Rajabov O, Fazliddin K, and Salimov Sh., **Substantiation of Parameters of the Fibrous Material Cleaning Zone**, International Journal of Engineering and Advanced Technology, vol. 9, No 3, (2020), pp. 1052-1057.

[8] Akbar Abrorov, Matluba Kuvoncheva, Ozod Rajabov, Mukhsin Mukhammadov and Shakhrillo Jumaev, **Method of thermal treatment of saw disk teeth of fiber- processing machines by laser quenching**, IOP Conference Series: Materials Science and Engineering, (2020), 862 032034.

[9] Yunusova Khurshida Erkinovna et.al. **Some comments on the monopoly of cotton in uzbekistan in the 50-80s of the xx century and its impact on the environmen**, Journal of critical reviews. 2020, 7(6): 51-53.

[10] Jurayev A., and Rajabov O., **Experimental study of the interactional of multifaceted and cylindrical spiky cylinder in cotton cleaner from small waste**, International Journal of Advanced Research in Science, Engineering and Technology. Vol. 6, Issue 3, (2019), pp. 8376-8381.

[11] Rajabov Ozod Isroilovich, **The influence of the mode of movement of the pieces cotton when interacting with a cotton grid**, International Journal of Advanced Research in Science, Engineering and Technology (India). Vol. 6, Issue 3, (2019), pp. 8455-8381.

[12] Ozod Rajabov and Ziyodullo Shodiyev, **Analysis of Small Fluctuations of a Multifaceted Mesh under the Influence of Technological Load from the Cleaned Cotton - Raw**, International Journal of Advanced Research in Science, Engineering and Technology, Vol. 6, Issue 10, (2019), pp. 11396-11399.

[13] Bekhruz Gaybulloev, Nigina Ergasheva, Ozod Rajabov, **The Structure of the Embroidery Machine and Dynamic Analysis of the Needle Mechanism**, International Journal of Advanced Research in Science, Engineering and Technology, Vol. 7, Issue 1, (2020). pp. 8376-8381.

[14] Anvar Djuraev and Ozod Isroilovich Rajabov, **Substantiation of the main parameters of the cylinder with multifaceted spiked of the cotton cleaner from small waste**, International scientific and practical conference Innovative ideas of modern youth in science, (2019), USA. P. 149-151.

[15] Mavlyanov Aybek Palvanbaevich, Rajabov Ozod Isroilovich and Yakubova Aziza Vakil qizi, **Study of the influence of the parameters of the plastic grate on elastic supports with nonlinear stiffness on the oscillation frequency**, International scientific and practical conference “Innovative ideas of modern youth in science”, (2019), USA. P. 152-154.

[16] Burns, M., Crossan, A. N., Kennedy, I. R. & Rose, M. T. **Sorption and desorption of endosulfan sulfate and diuron to composted cotton gin trash**. J. Agric. Food Chem. (2008), doi:10.1021/jf703631j.

[17] Funk, P. A. & Hardin, R. G. Energy utilization and conservation in cotton gins. Journal of Cotton Science (2017).

[18] A.M.Mahaboob Basha, M.Rajaiah, P.Penchalaiah, CH.Raja Kamal, B.Niranjana Rao. **Machine Learning-Structural Equation Modeling Algorithm: The Moderating role of Loyalty on Customer Retention towards Online Shopping**, International Journal of Emerging Trends in Engineering Research, Volume 8. No. 5, May 2020, pp 1578-1585.

[19] McAlister, D. D. & Rogers, C. D**. Engineering and ginning: The effect of harvesting procedures on fiber and yarn quality of ultra-narrow-row cotton**. J. Cotton Sci. (2005).

[20] Z. Shodiyev, A. Shomurodov and O. Rajabov. **The results of the experimental nature of the vibrations of the grid cotton cleaner**, IOP Conference Series: Materials Science and Engineering, 2020, 883 012169 https://doi.org/10.1088/1757-899X/883/1/012169

[21] Ozod Rajabov, Ziyodullo Shodiyev, Ikrom Inoyatov, Mastura Gapparova. **Analysis of the Technological Process of Cleaning Raw Cotton from Small Trash**, International Journal of Emerging Trends in Engineering Research, Volume 8. No. 9, September 2020, pp. 6022-6029.