International Journal of
Biological Engineering and Agriculture

ISSN: 2833-5376
Volume 2 | No 6 | jun -2023

ANALYSIS OF EXISTING DESIGNS OF CRUSHING MACHINES FOR PROCESSING SOLID WASTE

T.Q.Xankelov, K.J.Rustamov, S.S.Xamidov, S. S.Yusubjonov, Sh.M.Abdukarimova
Tashkent State Transport University, Tashkent, Uzbekistan

Abstract: The article is devoted to the analysis of the designs of sorting machines for processing solid household waste. Based on the analysis of the advantages and disadvantages of machine designs, analogues of machines have been selected. When choosing an analogue, not only the design features, but also the properties of recycled waste are taken into account.

Keywords: analysis, crushing machine, degree of grinding, solid household waste.

Introduction

Various equipment is used for crushing the constituents of municipal solid waste. The decisive factor influencing the choice of crusher design is the properties of municipal solid waste, the specific energy intensity of the waste crushing process, as well as the specific material consumption of the crusher design. Here it is necessary to add that the choice of the design of the crushing machine is also influenced by the quality of the products, versatility and maintainability [1; pp.4-11, 2; pp.7-9, 3; pp.12-16]. Figure 1 shows the classification of crushing machines by design [11, 12, 13, 14, 15, 16, 17, 18, 19, 20].

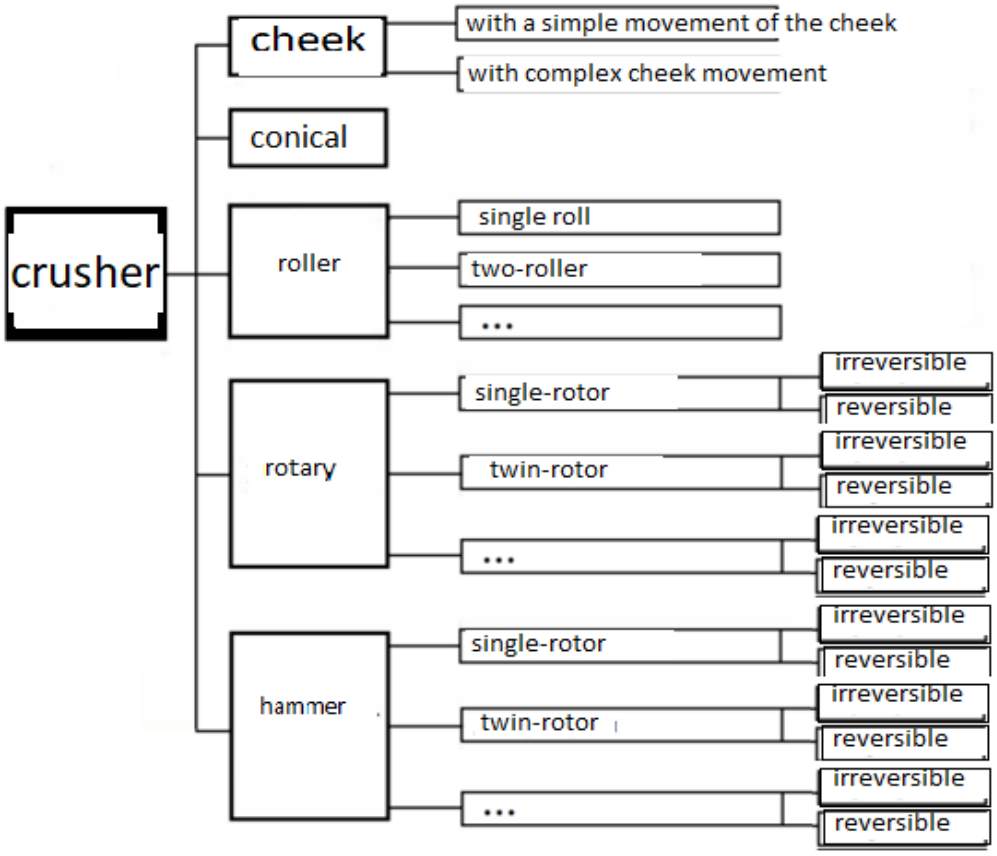

Fig.1. Crusher classification

Main Part

When choosing crushing equipment, it is necessary to take into account the significant characteristics of the equipment [21, 22, 23, 24, 25, 26, 27, 28]. Table 1 below presents an improved system of significant characteristics developed by the author.

Table 1. Crusher Significant Enhanced Performance System

crushers	The system of significant characteristics of crushers			
	Specific energy intensity	Specific material consumption-bone	Versatility	Cap. expenses
cheek	Very high(5)	Very high(5)	Low(4)	Very high(5)
cone	High(4)	High(4)	Low(4)	High(4)
Valkovaya	High(4)	High(4)	Low(4)	High(4)
Rotary	Low(3)	Low(3)	Low(5)	Low(3)
Molotkovaya	Low (3)	Low(3)	Low(4)	Low (3)^*

* the lower the crusher scores, the more efficient it is.

The analysis of table 1 shows that, according to improved indicators, hammer crushers have undeniable advantages over other types of crushers, especially when crushing organic waste components.

In hammer crushers, the force of impacts inflicted by impactors crushes solid waste components. Hammer crushers are generally designed to grind medium to low strength materials. The production of crushing machines ranges from 3 to 400 m^3/hour[4; pp.11-15, 5; pp.12-16, 6; pp.5-11]. Grinding of organic components is carried out:

- due to the impact of the hammer on the organic components of the waste and the impact of the components of the waste on each other;
- impact of organic components on the walls of the working chamber;
- collision of organic components on the blade of knives welded on the walls of the working chamber;
-between the organic components and the grate.

A significant part of the waste is crushed due to collision with each other.

Crushers include a crushing chamber with a grate at the bottom through which the crushed material is discharged, and a rotating shaft with beaters (impacting rotating tools, often called hammers) fixed or suspended on it. Hammer crushers come in two types - horizontal and vertical.

Figure 2 shows the design of a horizontal hammer crusher for crushing MSW. The machine was developed by the All-Russian Scientific Research Institute of Municipal Engineering. The waste is sent by means of a conveyor to the loading device 1, and then by a feeder to the working chamber, where grinding takes place with rapidly rotating hammers pivotally attached to the rotor 10. Waste fragments are fed to the plate 2, where additional grinding takes place. In addition, the grinding device is equipped with a bar 3, which crushes MSW. On the surface grate 4, additional grinding of the material takes place and fine waste falls on the lower conveyor.

Soft materials, as well as metal objects that are difficult to grind with hammer blows, hit the plate 9 from the end of the surface grate. Large pieces, moving the shutter 8, fall into the slot 7 and

are then taken aside, and the remaining material under the action of a toothed crusher, in which left 5 and right 6 rolls rotate at different speeds, grinding the material. When strong materials are fed into the crusher, one of the rollers moves back and the gap between the rollers increases, passing the object down to the collecting conveyor installed under the crusher.

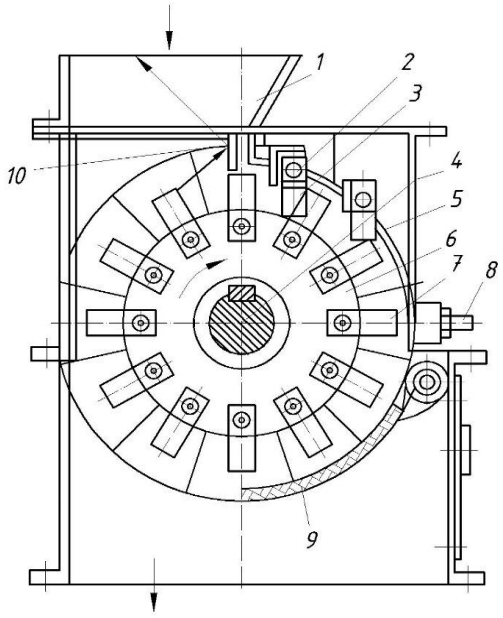

Fig.2. Hammer crushing machine designed by the All-Russian Research Institute of Municipal Engineering

The crushing machine for crushing solid waste designed by the All-Russian Research Institute of Municipal Engineering differs from conventional hammer crushers by the presence of "combs", between the fixed teeth-knives of which hammers rotating on the rotor pass, thereby increasing the crushing effect of the crushing machine. Hammers 7, hinged on the rotor 6, which is installed in the casing 4 of the crushing machine, act on the waste coming through the feed opening 1. A crushing plate 5 and combs are also attached to the body. The teeth of the combs 3 are suspended on the axes 2. In front of the first comb, a breaking plate 10 is installed. After the crushing plate, a breaking bar is installed, the distance of the working edge of which to the circle of rotation of the hammers can be adjusted with a bolt 8. A grate 9 is installed at the bottom, the position of which relative to the hammers can also be adjusted. Indestructible objects are thrown by hammer blows onto the impact plate 10, and from it they ricochet into a vertical shaft, where they lose speed, fall into the unloading chute and are removed. It should be noted that the tests of crushing machines, made according to the above scheme, revealed their shortcomings, for example, during processing, various fibrous materials (rags) were wound on rolls and quickly brought them to a non-working state. At the same time, the principle of the machine seems to be promising; fine-tuning the design is an urgent task.

Figure 3 shows a crusher with a vertical shaft, which is installed in the Minsk Waste Processing Plant.

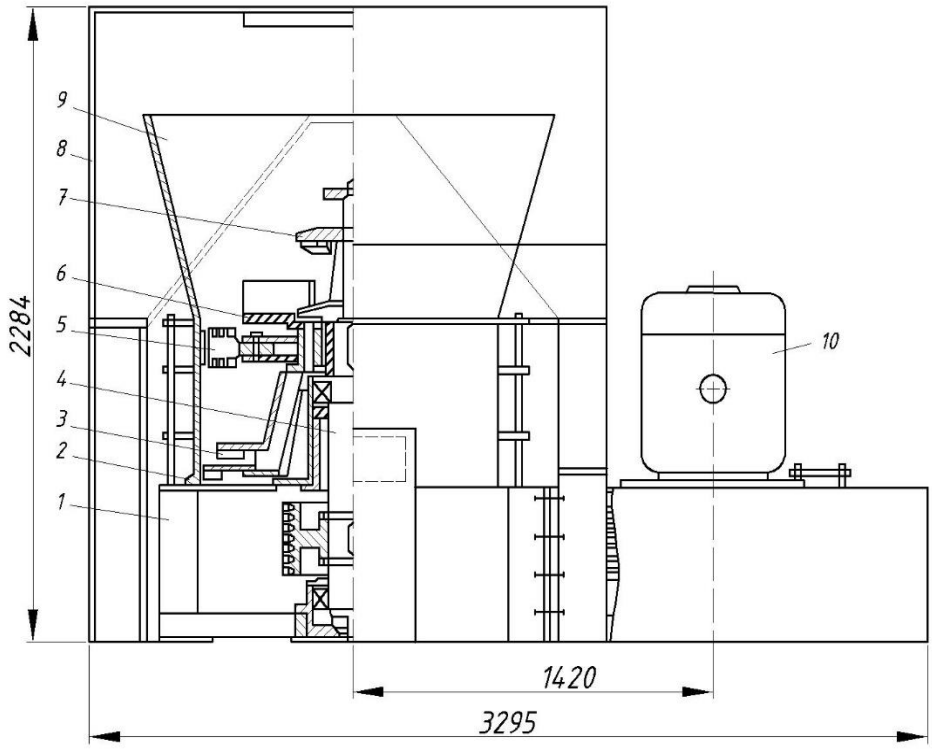

Fig.3. Vertical Shaft Hammer Crusher Separator

The crushing machine - separator is designed for additional grinding of compost and glass during the processing of solid waste. The crushing machine (DM) consists of a base 1, on which the crusher body 2 is mounted, a vertical drive shaft 4 and a crushing element, including hammers (beater) 5, rippers 7, a spreader 6, with knife guides and a discharge disk 3. From the top to the body a loading hopper 8 is attached, inside of which a receiving cone 9 is placed.

The shaft of the machine is driven by an electric motor 10 and a V-belt drive. The compost to be crushed is fed into the receiving hopper and falls on the cultivator, made in the form of three conical discs installed one above the other.

It should be noted the abundance of various designs offered by leading firms in the USA, Germany, France, England and Japan for the processing of solid waste.

In most cases, these are hammer and impact crushers, which have been modified to reflect the specifics of waste processing. For example, impact and hammer crushers are equipped with beak-shaped beaters and hammers that crush and tear the material being processed. Impact plates are not smooth or corrugated surfaces, but are equipped with protrusions with sharp edges (knives). When crushing waste with a significant proportion of rags, paper, polyethylene, for example, in the National Recycling (USA) crushers, the crusher rotor is reversed, which increases the tearing and abrasive effect [1; pp.3-77; pp.23-26, 8; pp.11-15, 9; pp.7-11, 10; pp.32-36].

Figure 4 shows a hammer crusher from Tollemache (Great Britain).

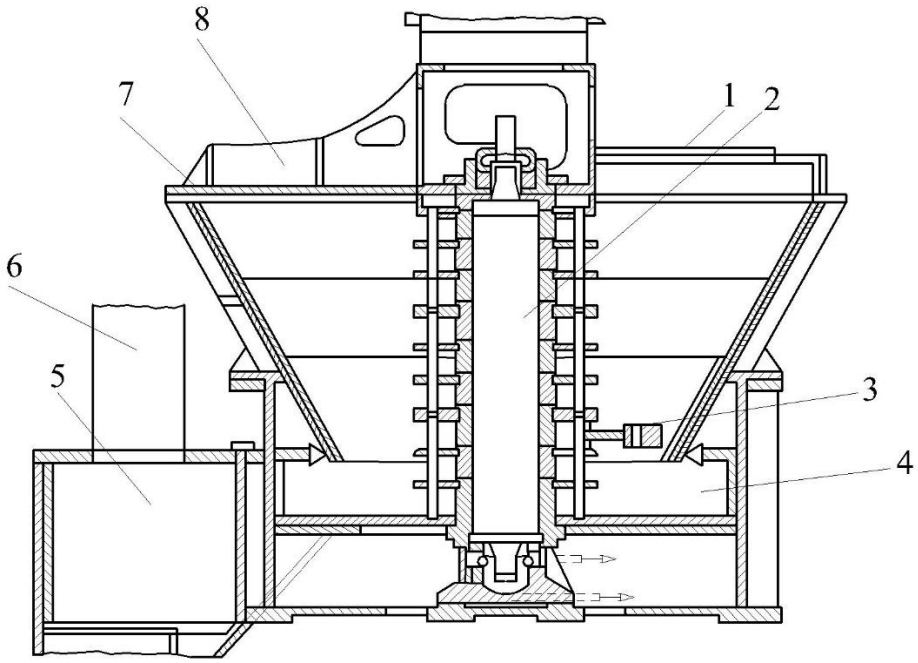

Fig.4. Crusher of the Tollemache system (Great Britain)

In the Tollemache crusher, the raw material is loaded into opening 1 of the cover 7 of the hatch and enters the working area of the grinder, where it immediately falls under the action of a strong air flow created by the vertical rotor 2. Soft components are reflected by hammers 3 and the air flow is directed to the opening 8 of the cover 7. The crushed waste enters the cylindrical chamber 4, from where it enters the cyclone 5 and further down to the discharge conveyor, and the dusty particles are taken out into the exhaust pipe 6. The cyclone 5 is placed on a carriage that allows it to be removed from the DM during repair work.

The technical characteristics of the Tollemache DM system are presented in Table 2

Table 2. Technical characteristics of the DM system "Tollemache"

№	Main parameters of crushers				
1	Type	42	58	72	92
2	Productivity, t/h	15-18	30	40	60-70
3	Drive power, kW	110-148	258	368	552-736

Over 150 Tollemache type 42 crushers installed in various countries. The largest shredders type 92 are used in the USA and Japan.

Выводы

1. An analysis of the principles of operation of all the above impact crushers, as well as a patent search on this topic, showed that waste is effectively crushed after passing through preparatory manual sorting and fractional sorting on drum screens on hammer crushers.

2. Based on the analysis of the advantages and disadvantages of impact crushing machines, it was found that hammer crushers with a vertical shaft are more efficient than those with a horizontal shaft.

3. Based on the use of the principles of physical modeling, prototypes of impact crushers have been developed.

References:

1.Ханкелов Т.Қ., Мухамедова Н.Б., Аслонов Н.Р.,Илхомова М.Н. Устройство для сортировки твёрдых бытовых отходов//Электрон журнал: Транспорт Шёлкового Пути №1, 2020 г. С.33-42.
2.Ханкелов Т.К., Комилов С.И. Требование к уплотнению лессовых грунтов земляного полотна.ТДТрУ.Science journal vehicles and road, 2023y, №1.Issue 1,2.
3.Ханкелов Т.К., Мухамедова Н.Б., Кудайбергенов М.С., Хамидов С.С. Қаттиқ маиший чиқиндиларни майдалаш чиқиндиларни майдалаш жараёни учун ўхшашлик критерийларини аниқлаш.Eurasian journal of academic research volume 2, Issue 13, December 2022, pp.533-537.
4.Khankelov T.K., Mukhamedova N.B., Komilov S.I., Mirxoliqov S.M. System of Indicators for Evaluating the Efficiency of Municipal mashines. International Journal of Advanced Research in Science, engineering and Technology.ISSN:2350-0328, Vol.9,Issue 11, November 2022.pp.20184-20187.
5.Ханкелов Т.Қ., Иброхимов С.И., Вахобов Ж.В. Ёнлама кенгайтиргич ва вертикал панжара билан жиҳозланган бульдозер отвали ёрдамида қаттиқ маиший чиқиндиларни қазиш жараёни математик модели. Eurasian journal of Law, Finance and Applied science.
6.Khankelov T.K., Mukhitdinov A.S. Alimov T.Y. Analysis of works Devoted to the study of the shape, of the transferse profile of the working bodies of the moldboard type. ISSN(E):2347-6415. Vol.10, Issue 6, June (2022).
7.Ханкелов Т.К., Мухамедова Н.Б.Устройство для сортировки твердых бытовых отходов оснащенной вращающимся ротором. International Scientific Conference “Innovative trends in Science practice and Education, 2023, Germany” .pp.116-121.
8. Khankelov T.K., Faiziev T.Z., Mukhamedova N.B.,Komilov S.I.Development of similarity criteria for the grinding process of solid household waste on ball,Mills. Voume 2, Issue 12, November 2022, ISSN 2184-2020, pp.372-375.
9. Ханкелов Т.Қ., Мухамедова Н.Б., Рашидов Б.У., Ниязов А.А. Система показателей оценки эффективности коммунальных машин. “Авиация ва космик технологияларда таълим ва илмнинг долзарб муаммолари” мавзусидаги Ҳалқаро илмий техник анжумани, 10-11 ноябрь, 2022 йил Ташкент, Узбекистоню Анжуман маърузалар тўплами, 380-385 бетлар.
10.Tavbay Khankelov, Nafisa Muxamedova. Determination of main parameters of the devise for sorting solid household waste. European science review. Vienna. 2017., №11-12, pp.160-163.
11. Isyanov, R., Rustamov, K., Rustamova, N., & Sharifhodjaeva, H. (2020). Formation of ICT competence of future teachers in the classes of general physics. *Journal of Critical Reviews*, *7*(5), 235-239.
12. Juraboevich, R. K. (2020). Technical solutions and experiment to create a multipurpose machine. *International Journal of Scientific and Technology Research*, *9*(3), 2007-2013.
13. Rustamov, K. J. (2021). Innovative Approaches and Methods in Teaching Technical Subjects. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(5), 1861-1866.
14. Askarhodjaev, T., Rustamov, K., Aymatova, F., & Husenova, G. (2020). Justification of the hydraulic system parameters of the excavation body of a multi-purpose road construction vehicle based on the TTZ tractor. *Journal of Critical Reviews. Innovare Academics Sciences Pvt. Ltd. https://doi. org/10.31838/jcr*, *7*, 40.

15. Rustamov, K. J. (2019). Experimental Work of the Hydraulic Equipment of the Multi-Purpose Machine Mm-1. *International Journal of Recent Technology and Engineering (IJRTE) ISSN*, 2277-3878.
16. Dj, R. K. (2019). Experimental Work of the Hydraulic Equipment of the Multi-Purpose Machine MM-1. *IJRTE, November*.
17. Rustamov, K. (2022). The Mathematical model of a positioning hydraulic drive: Mathematical model of a positioning hydraulic drive. *Acta of Turin Polytechnic University in Tashkent*, *12*(2), 76-81.
18. Rustamov, K. J., & Tojiev, L. O. (2022). Types of Steering and Their Design Aspects. *Indonesian Journal of Innovation Studies*, *20*, 10-21070.
19. Рустамов, К. (2021). ОБОСНОВАНИЕ ОПТИМАЛЬНЫХ УГЛОВ ПОЗИЦИОНИРОВАНИЯ РАБОЧЕГО ОБОРУДОВАНИЯ ПРИ КОПАНИИ ГРУНТА. *Транспорт шелкового пути*, (2), 54-59.
20. Рустамов, К. Ж. (2009). Анализ гидропривода современных строительно-дорожных машин. *Строительные материалы, оборудование, технологии XXI века*, (1), 44-44.
21. Rustamov, K. J. (2023). Technical and Economic Indicators of a Multi-Purpose Machine. *Nexus: Journal of Advances Studies of Engineering Science*, *2*(2), 48-52.
22. Rustamov, K. J. (2023). Feasibility Study of the Designed Working Equipment of the MM-1 Machine. *International Journal of Discoveries and Innovations in Applied Sciences*, *3*(2), 92-97.
23. Rustamov, K. J., & Bazarbaev, B. M. U. (2021). Theoretical study of the power balance of the equipment of a single bucket hydraulic excavator under the conditions of determining the productivity. In *International Conference on Agriculture Sciences, Environment, Urban and Rural Development.* (pp. 32-37).
24. Maksudov, Z. T., Kudaybergenov, M. S., Rustamov, K. J., & Mukhamedova, N. B. (2023). Issues of Development of an Industry Standard for Mechanized Costs of Single-Bucket Excavators in the Construction of Roads. *Nexus: Journal of Advances Studies of Engineering Science*, *2*(5), 47-51.
25. Usmanov, I. I., Rustamov, K. J., Magdiyev, K. I., Kudaybergenov, M. S., & Ulashov, J. Z. (2023). Issues of Modernization of Mechanical Engineering on Innovative Basis. *Nexus: Journal of Advances Studies of Engineering Science*, *2*(5), 1-4.
26. Astanakulov, K. D., Rustamov, K. J., & Ulashov, J. Z. (2023). Cutting Branches of Trees and Possibilities From Their Use. *Nexus: Journal of Advances Studies of Engineering Science*, *2*(4), 74-83.
27. Rustamov, K., Usmanov, I., Komilov, S., Egamshukurov, P., & Pardaboyev, Z. (2023). Modern Practice of Ensuring the Operability of Construction Machines. *Nexus: Journal of Advances Studies of Engineering Science*, *2*(3), 114-117.
28. Rustamov, K., Usmanov, I., Komilov, S., Egamshukurov, P., & Pardaboyev, Z. (2023). ASPECTS OF THE IMPACT OF TECHNICAL OPERATION. *Nexus: Journal of Advances Studies of Engineering Science*, *2*(3), 110-113.