International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 3 Issue 5 ǁ May 2015 ǁ PP.56-60

The research progress of agricultural straw crushing machinery and the main problems discussed

QiangHe, Jian-xinQiu
(College of Mechanical Engineering, Shanghai University of Engineering Science,Shanghai,China)

ABSTRACT *: Most of the agricultural straw materials need to be in front of the exploitation and utilization of appropriate treatment, such as crushing process only when the straw crushing grain size and meet certain requirements, to be prepared for the subsequent research and use of straw. Straw raw material after the crushing process, due to the material particles from large to small, relative surface area increased, promoted the physical effect, increasing the speed of its participating in chemical reactions.Normally, after crushing the thinner of the material particle size, the subsequent processing and use the better .Therefore, straw crushing processing technology in the preliminary processing and transformation of straw utilization plays a key role in the process, only the continuous improvement of the existing and development of new fine crushing technology can promote our country's comprehensive utilization of straw.*
This paper firstly introduces the significance of agricultural straw fine crushing, and then describes the working principle and structure of straw slimer, and discusses the research status of fine grinding mill, and the main problems of the crusher equipment are discussed, and finally prospects the development trend of agricultural straw fine crushing equipment.
Key words-*agricultural straw, crushing, discussion,machinery, discussion,the development trend*

I. Introduction

Most of the straw materials need to be in front of the exploitation and utilization of appropriate treatment, such as crushing process only when the straw crushing grain size and meet certain requirements, to be prepared for the subsequent research and use of straw [1].Straw raw material after the crushing process, due to the material particles from large to small, relative surface area increases, promotes the physical effect, increases the speed of its participating in chemical reaction.Normally, after crushing the thinner of the material particle size, the subsequent processing and use the better .When fuel straw particles as the compression molding, straw particle size is fine, due to the decrease of the relative surface area, promotes the bonding between the particles and the particles in the process of compression. GAO Wei and others**[2]** did research about influence factors for straw pellet fuel density and granulation rate, grain density after forming reaches the international standard 1.12g•cm^{-3} premise, particle size in a certain range, the smaller the particle size of raw material, granulating rate is higher, the forming of the grain density is higher, especially, the particle size in 1.66 mm, granulating rate reach more than 97%, the largest particle size in 2.5 mm, the finished product highest density of particles;When the straw as raw materials for the pyrolysis liquefaction, gasification, straw particle size in a certain range, the smaller the value, the smaller the relative surface area, the faster the straw particle heating rate, the stronger the pyrolytic role, pyrolysis products of produce efficiency is higher.Hui Shi-En and others**[3]** did research about effects of heating rate, atmosphere and particle size on corn stalk's pyrolysis characteristics,analysis of research trials result is: the particle size range 0- 0.8 mm, with the increase of particle size, initial temperature of maize straw pyrolysis temperature, peak temperature and terminate all showed a trend of increase, at the same time, the maximum weight loss rate has increased slightly, the material is fine, the greater the particle surface area of unit volume can be involved in the reaction, thus the reaction's temperature is reduced, the pyrolysis process of chemical reaction speeds.

According to the size of the raw material and finished product particles or particle size, grinding can be divided into coarse crushing, fine crushing, fine crushing (super fine crushing) and superfine grinding four types (see table 1)**[4]**.

Table 1 crushing granularity control type and powder products

Shattered type	Coarse grinding	Fine crushing	Fine crushing and super fine crushing	Superfine grinding
Particle size of the finished product（mm）	10~5	5~0.1	＜100（μm）	＜10~25（μm）
Raw material particle size (mm)	10~100	5~50	5~10	0.5~5

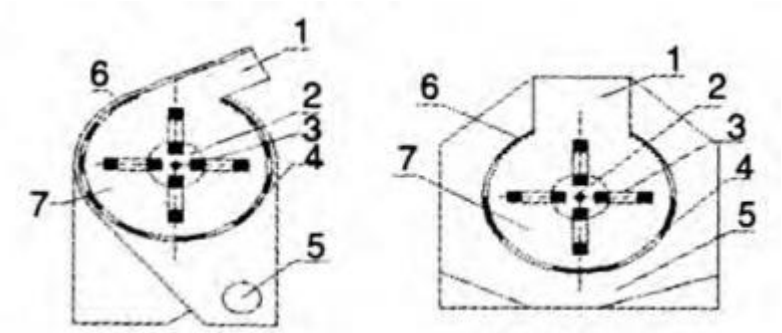
Therefore, straw crushing processing technology in the preliminary processing and transformation of straw utilization plays a key role in the process, only the continuous improvement of the existing and development of new fine crushing technology can promote our country's comprehensive utilization of straw.

In China, mill has several decades of development time, because of hammer type crusher advantages of simple structure, good versatility and strong adaptability, at present, straw fine crushing equipment widely used hammer type crushing structure. This paper firstly introduces the significance of agricultural straw fine crushing, and then describes the working principle and structure of straw slimer, and discusses the research status of fine grinding mill, and the main problems of the crusher equipment are discussed, and finally prospects the development trend of agricultural straw fine crushing equipment.

II. Straw Principle and Structure of Fine Crusher

Traditional straw fine crusher working principle is: the biomass straw cut off by the other crushing machinery such as Guillotine cutting machine are fed into crushing chamber by feeding mouth, through high-speed rotating hammer blow, resulting in a certain degree of crushing, at the same time, material at high speed was thrown on the tooth plate and sieving slice in the interior of crushing roomand through tooth plate collision, the screen piece rub to obtain further grinding .Crushing process is repeated in the crushing room, until the material can be through the mesh. According to the feeding way, it is divided into tangential and top feed two types, its structure diagram as shown .

Hammer crusher system generally consists of feeding device, the body, the rotor, tooth plate screen (plate), discharging device, and control system and other parts. Set of hammer frame plate and the hammer of the rotor is supported by the bearing inside the body,An upper body installs teeth plate, a lower body installs screen films surrounded the whole rotor, which form a crushing chamber. Hammer of connection around the perimeter of the hammer frame plate with peg, between the hammer are spacers (or gaskets), Hammer of stagger to each other**,** evenly arranged along the axial distribution according to certain rule. Hammer crusher structure as shown in fig.1.



a.Tangential feed type**b.** Top feed type
1-Feed port 2- rotor 3-Hammer 4-Screen mesh 5-spout 6-Tooth plate 7-Crushing chamber
Fig.1 Hammer type crusher structure diagram

III. The Current Research Status of Agricultural Straw Crushing Machinery

In recent years, for fine crushing equipment uneven grinding particle size, high power consumption and low degree of electricity production, crushing and separation efficiency of the hammer type crusher carried out extensive research, thus it appears the different types of grinder.

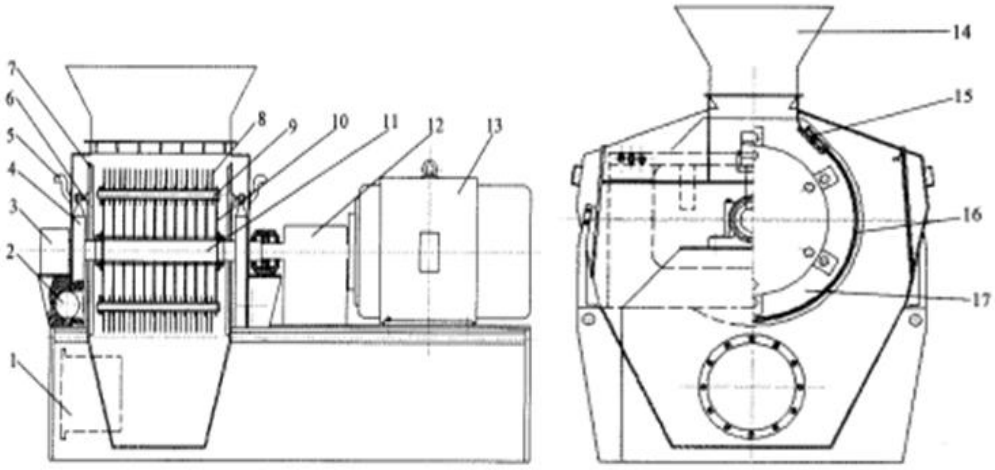
3.1The Crushing Mill that Changes the Shape of the Cavity

In view of the hammer type crusher, the existence of the material circulation layer causes crushing and separation efficiency low. A lot of people trying to change the shape of the crusher's crushing cavity to destroy the formation of circulation layer, so as to improve the efficiency of separation, mill appears with different shape of the crushing cavity, likes water droplets shape, oval, eddy current type, especially, water droplets form are the most widely used. The several crushing cavity shape of crusher in crushing the improvement of performance has been made, but the effect is not very good.To seek better ways of improvement, LIU Wei Fengand others [5] from mechanical and electrical engineering college of Inner Mongolia agricultural university are on the basis of the analysis of the crushing mechanism of mill, put forward the screen piece into trapezoidal round into the crushing chamber, although using trapezoidal screen pieces than the original structure is complicated, but in theory, it will be very good mill grinding efficiency, improve its performance, because it can effectively destroy crush interior circulation layer, the second is to increase screen manage area, three is to strengthen the grinding performance.

3.2Introducing Vibration Mill In the Separation Device

Shanghai Spring Valley Industrial Co., Ltd. [6]put forward and developed vibrating hammer crusher, its technical characteristic is a cross wide type multilayer sieve, sieve piece divides inner and outer sieve, which uses sieve's high frequency severe vibration, destroys the circulation layer, mesh opening rate always be high, increases yield and grain size uniformity, the hammer type crusher separation efficiency is also improved.

Fu Min andothers[7] from northeast forestry university develop a new type of straw pulverizer, through the increase the number of hammer and terminal velocity, and the axial vibration sieve type so as to realize the rapid screening of the crush of finished material, according to the sample test result is a kind of efficient fine granularity of straw crusher.Hammer crusher structure as shown in fig.2.



a. Front view b.Left view

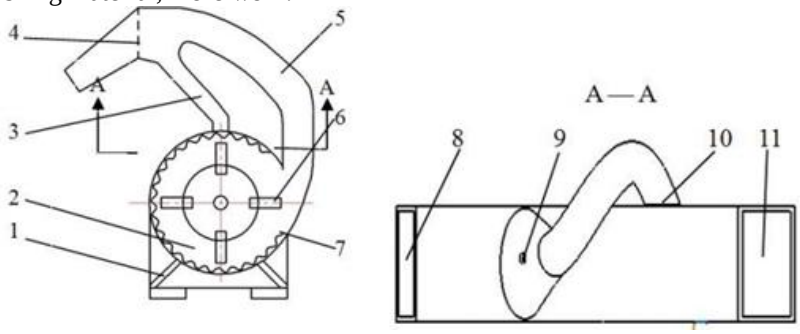
1-material outlet 2-micro vibration motor 3- bearing pedestal 4-vibration sieve bracket 5-air inlet 6-vibrating spring 7-end plate 8-hammer 9-axis pin 10-hammer frame plate11-spindle 12-coupler 13 -motor 14-feed port15-tooth plate 16-sieving slice 17-crushing chamber

Fig.2 axial vibration sieve type straw crusher structure diagram

3.3Separation Device Modified Mill

Inner Mongolia university of science and technology[8] [9]developed a new kind of screening machine hammer type material of the crusher on the basis of improvement to the traditional hammer type crusher structure, the crushing room doesn't install the screen, but the screen is installed in the separation plant export position, it eliminates the crushing chamber circulation layer, Hammer crusher structure as shown in fig.3.

Shredded material ejection in the hammer effect and high speed rotating hammer formed under the action of the airflow to be delivered to the separation device of screen to screen, conform to the requirements of the granularity of the material sieving isolated, not through the screen of the material in the center of gravity and the crushing chamber through the back under the dual role of negative pressure feeding tube back into the crushing chamber and then continue to pieces, and so on of crushing, conveying, screening, back to crush until all material complete crushing material, more work.



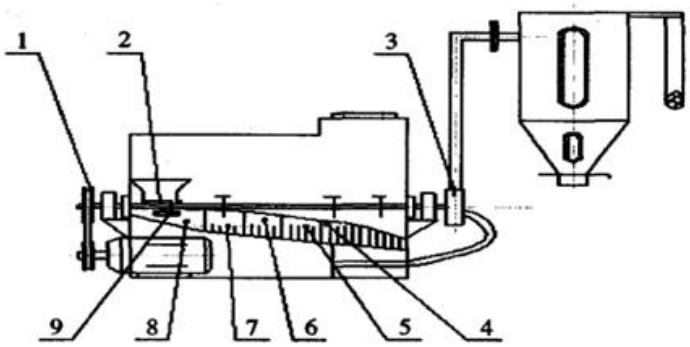
1-rack2- crushing chamber3- return Tube4- sieving slice5- separation device6- hammer7-tooth plate 8- material outlet 9- opening outlet 10- feeding back outlet 11- material inlet

Fig.3 new hammer mill structure diagram

3.4 Multi-stage Crushing Way and New Technology-Based Modular Mill

Multistage mill generally adopts the structure of the axial double crushing chamber, primary crushing chamber formed by a cutting device and a hammer plate structure, mainly to finish coarse grinding material processing; Generally, the secondary crushing chamber that adopts thin hammer type structure for further fine crushing materials to meet the requirements of grinding particle size of particles and through the sieve isolated.

Heilongjiang agricultural mechanical engineering research institute[10]has developed a new type of combined straw crusher. On the structure, it adopts single chamber structure to cut materials in the axial direction, crushing chamber is made of super wide type and double cavity crushing structure, and two crushing chambers are full of high density and different thickness hammers .On the processing technology, unlike traditional pulverizer,both to rub and to crush in a crushing chamber, but by the first chop in chop room processing into stem pieces, then under the action of wind are sent to knead cavity processing into filaments, the last to be delivered to the crushing cavity processed into particles. The machine has some characteristics such as simple structure, simple process, low energy consumption and low production cost.Hammer crusher structure as shown in fig.4.



1-transmission system 2-feeding system 3-the wind a discharging system 4-crushing chamber 5-crushing assembly 6-cubbing cavity 7-cubbing assembly 8-chopping cavity 9-chopping assembly

Fig.4 new straw crusher structure diagram

IV. Discussion OnMain Issues About Agricultural Straw Fine Crushing Equipment

At present, the straw crushing machinery has have a certain scale and level, but also on structure and performance are widespread for sieving rate is low, screening difficulties lead to low productivity, high energy consumption, crushing material particle size uneven, adapt to the narrow range for the material, lead to shatter such problems as low efficiency, short service life.

In recent years, the emergence of the crushing chamber shape change, separation plant is introduced, the axial or radial movement of the grinder and composite crusher, sieving slice still installed around the hammer rotor group in the interior ofcrushing chamber, to some extent ,these crushers can effectively destroy the circulation layer, but some material particles that meet the requirements of the granularity are still difficult to through the screen mesh, leading to excessive crushing, the crushed material is uneven, the material temperature rise high and waste more power. BAI Yu with others from Inner Mongolia university of science and technology design a new type of crusher, the screen isn't installed in the interior ofcrushing chamber, but in separation plant export position, which eliminates the crushing chamber circulation layer, effectively solves problems of the difficulty for screening of excessive crush, temperature rise, screen surface is easy to wear and tear. But due to the action from return tube's negative pressure, and the structure of the separation device, compared with the traditional mill, separation efficiency is lower , the researchers on the machine makes a detailed theoretical and experimental research to find out the reasons of the existence of the problem, but did not fundamentally solve these problems. Generally, to speed up the material through the screen mesh, mill can use suction device or pneumatic conveying device, but due to the existence of the material circulation layer inevitably leads to mill low screening efficiency, on the other hand, for materials with fiber , due to the size of the fiber shape is bigger and likes a needle, the existence of the screen surface can also lead to sieving rate low. Therefore, it can develop other efficient screening equipment instead of screen mesh, such as the use of cyclone separator for screening, particles do not conform to the requirements of the particle size through the pipeline return to the crushing chamber continue to smash.

Vibrating hammer crusher likes Shanghai Spring Valley Industrial Co., Ltd. put forward and developed, the direction of the crusher screen's the maximum amplitude is perpendicular to the direction of the rotor axis, it needs to strictly control the size of the amplitude, screen mesh or hammer easy to break, causing unqualified product size, material leakage and safety accidents, thus affecting the popularization and application.

Combined mill generally has a variety of function such asguillotine cutting, grinding, rubbing in a body, to a certain extent, improve the quality and efficiency of crushing, reduced people's participation, reduces the labor intensity of workers, is the ideal of new type fine crusher developed in recent years. For disc type composite crusher which adopts guillotine cutting way, in the process of cutting disc is larger impact, and disc stiffness often can't meet the requirements, results in uneven cutting, the blade wear serious, reduces the cutting quality. The impact disc can cause shock effect of the subsequent grinding process hammer mill for the material and cause mill vibration. In order to avoid this kind of situation, can use drum guillotine cutting way, to ensure that the work load and little mill vibration.

Whether single cavity or multi-cavity crushing chamber of hammer type crusher, it usually has only one speed, that a hammer mill has a unique blade tip speed, which determines the hammer blow and blow number of time units for the material. But for different materials, they have different material strength, brittleness and toughness, therefore, optimal values of linear velocity at the end of the hammer are different[11].

In order to adaptto the characteristics and requirements of different straw material crushing, it can reference variable frequency speed regulating device or control the turning speed of the hammer type crusher adopt mechanical control device to improve the grinding performance, expanding the scope of the crusher and adaptation of agricultural straw. In particular, due to guillotine cutting mechanism and subsequent grinding, kneading mechanisms do not lie on the same axis, can be introduced separately for guillotine cutting mechanism and subsequent comminution mechanism variable-speed control devices, cutting and grinding wider ratio range of material value, this solves the problem of the combination crusher adapts to narrow scope of material.

V. Conclusion

Today, agricultural straw resources are developed greatly, straw processing is necessary to consider steps to meet certain fineness of biomass particles is a precondition for subsequent processing. On the basis of the existing straw crusher to improve and perfect, straw fine crusher's design research and development and processing technique are combined, integrate equipment research and development and process research, study out a new combination of crushing and classification of closed circuit process, develop more high productivity, low energy consumption, high screening ratio, adapt to the range of materials straw crushing equipment is the development direction of fine crusher in the future.

Acknowledgements

This project is sponsored byShanghai Science and Technology research projects focus on agriculture(13dz1913800).

References

[1] ZU Yu,HAO LING, DONGLiangjie.The Research Situation and Prospect of Straw-Muller in China [J]. Journal of Anhui Agricultural Sciences. 2012, 40(3): 1753-1756, 1759.

[2] GAO Wei, LI Cheng-hua, WANG Shi, WEI Ping, LU Chang-yi. Influence Factors for Straw Pellet Fuel Density and Granulation Rate [J]Journal of Shenyang Agricultural University . 2011-10, 42(5):583-587.

[3] HUIShien, LIANG Ling, LIU Changchun, WANG Denghui, CHEN Zhiliang, JING Qiangzheng. Effects of heating rate, atmosphere and particle size on corn stalk's pyrolysis characteristics [J].Thermal Power Genertion. 2014, 43(5):59-64.

[4] LIUShu-li , WANG Hua. Application and Research of Superfine Grinding Technique in Food Industry[J]. Drying Technology& Equipment. 2007, 5 (1):35-38.

[5] Liu Weifen, Liu Wenguan ,Ma Yanhua. The Theory Analysis and Experimental Study on the Special Type Grinding Chamber of Hammer Mill [J].Journal of Agricultural Mechanization Research.2010 , 32(2): 63-65,67.

[6] ZHANG Lei, RUAN Jing-lan. The Analysis of Influence Factor and Research Stayus of Hammer Mill [J] .Packaging and Food Machinery.2013 , 31 (6): 55-57.

[7] Fu Min, Li Rui, Ma Lei. Development and test of straw grinder with axial vibration screen type [J]. Transactions of the Chinese Society of Agricultural Engineering . 2012, 28 (22): 16-22.

[8] BAI Yu.Research and design on the separation device of a new feed hammer mill[D] .Master thesis, Inner Mongolia University of Science and Technology.2013.

[9] SUN Hongbin .Study and Research on improve the workefficiency of the feed hammer mill[D]. Master thesis, Inner Mongolia University of Science and Technology.2013.

[10] ZHANG Bei, ZHAO Ping ,CHENWeiXu, JIN Juanpeng.The development of the new essence straw powder machine [J]Farm MachineryUsing& Maintenance. 2011 (6): 51-52.

[11] WANG Jing,NIUShuqing, WANG Peng ,MU Xiuming . The effect of the hammer type feed mill main factors for the performance or work [J] Feed Research.2010(4):64-67,71.