Advance Journal of Food Science and Technology 7(5): 344-347, 2015
DOI:10.19026/ajfst.7.1322
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: September 07, 2014 Accepted: October 12, 2014 Published: February 15, 2015

Research Article

Design of Turning and De Blocking Machine or the Fermentation of Ripe Puer Tea Heap

Wu Xiaoqiang
College of Mechanical Engineering, Inner Mongolia University for the Nationalities, Tongliao, Inner Mongolia 028000, China

Abstract: The fermentation of puer ripe tea once generally requires about raw materials 10t. In the meantime, it needs workers manually to turn 4-5 times. This will require not only intensive labor, but also improving the degree of cleaning. For turning operations in fermentation process of puer tea, in order to reduce labor intensity of workers, through researching the entire turning and fermentation process, we design roller double-helix arrangement blade-type turning machine for the fermentation of tea heap and make innovative design of turning device and optimal design of key working parts. In this study the designed turning machine which is mainly composed of turning devices, transport equipment and power devices, through organic complexes of various parts, complete turning operations of puer tea.

Keywords: Cooked tea, fermentation, puer tea, turning machines

INTRODUCTION

Puer'special raw materials, environment, processing technology, "Solid State Fermentation" and storage conditions give the tea diversity of quality and the unique nature of function (Xue *et al*., 2012). In recent years, due to the unique health benefits of tea, there arean increasing number of consumer groups, setting off a national and even worldwide consumption boom of puer tea (Huang *et al*., 2012). In this trend, consumer' demand for natural, high-quality, healthy, safe, pollution-free tea is also increasing. However, research and development of puer tea at home and abroad started late. Its level of automation, standardization, industrialization is low and especially in terms of the process of fermentation for the tea research is still in a relatively backward state (Luo *et al*., 1998). At present, processing of puer tea still remains in the traditional processing model. Workshops account for a large proportion.

Fermentation process of tea takes 45 days or so. Existing manual turning process of tea fermentation process is: turning→shoveling→de blocking→water mixing→piling. The process determines the unique color, flavor, taste, shape of tea (Shao *et al*., 2011). In the tea fermentation process, it is needed to go through turning operation three to four times, making the entire stack of tea from top to bottom able to ferment evenly to achieve the desired results of quality. Turning is an important step in the tea processing (Jiao *et al*., 2010). By turning, caking tea blocks are scattered, thereby reducing the temperature of the stack of tea to prevent deterioration caused by high temperature in tea (Gu *et al*., 2002). By mixing different fermentation levels of internal and external tea heap, it makes tea ferment evenly to improve the quality of tea. Therefore, turning is the key to the formation of quality characteristics of tea and is the most important part of tea processing. However, ordinary turning of tea fermentation is carried out by hand, which needs large intensive labor and is difficult to achieve large-scale production and clean production (He *et al*., 2002).

In this study, for the problem that fermentation turning relying on manual operation, intensive labor, poor working conditions and low production efficiency during the production of tea fermentation, we design the tea fermentation turning machine. The device can make a one-time completion of turning, de blocking, transportation and other technology of tea fermentation turning process, which achieves mechanization operations of turning, improves production efficiency and frees the workers from heavy manual labor.

PROCESS DESIGN OF PUER TEA TURNING MACHINES

Materials: MIn order to reduce labor intensity, it is urgent to develop an automatic turning machine. Combined with the production state of puer tea inYunnan, the of several development trends are summed up as follows:

- Clean, reducing direct contact of manual use of tools with the tea and improving mechanization water production mode of production operations.
- Miniaturization, researching fermentation equipment with small and medium-sized production, which is applicable to the use for

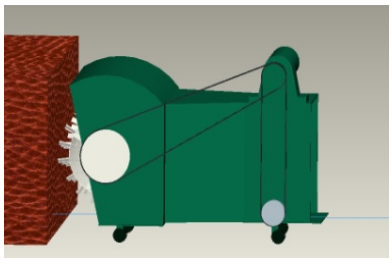

Fig. 1: Schematic turning machine work

different sizes of tea factory, in order to avoid the limitations of the site.

- Practicality, simple structure, easy operation and easy maintenance. Yunnan tea factories which are major in mountains are lack of staff and resources for equipment maintenance, so practicality is an important standard to determine whether the equipment can be promoted.

According to GB requirements of regulations for tea processing, tea processing equipment must also meet the following criteria:

Related equipment for puer tea processing should not use metal materials which may bring dirt and paint manufacturing components which may contact with tea. The use of bamboo, rattan, odorless wood and other natural materials, stainless steel, appliances and tools produced by food-grade plastic are advocated. Processing facilities, appliances and tools should be cleaned before use and regularly disinfected. Device settings should meet the technical requirements, have reasonable layout and ensure compact convergence of the preceding and the following process. The amount of dust emissions shall comply with the provisions of GB3841. Processing equipment shall take the necessary shock proof measures. Workshop noise should not exceed 80DB. Equipment needs regular maintenance and oil must not spill when each part refuels as shown in Fig. 1.

THE OVERALL DESIGN OF TURNING MACHINE SYSTEM

Working principle of turning machine: The work process of the machine is that turning device of turning machine is driven by the motor drive system. Push-type rack assembly, with the use of a motor and reducer, drives turning device and delivery devices, to achieve turning operation of turning machines. Output shaft of motor and the turning shaft with belt connection drive the rotation of turning device. As turning machines are at work, the rotation of turning devices start and rake teeth of drum cuts tea heap while throwing the tea behind the transfer device to simulate artificial raking operations offer mentation heap with rake. Transfer deviceis placed beneath of the drum turning device. With the turning machine moving forward, it simulates artificial spading way to make tea which is raked spread pushed backwards to the rear of the turning machine. At the same time the motor output shaft and the drive shaft is connected by a belt, for driving the conveyor to transport tea backwards.

Working parameters of turning machine: The work of turning machine implements single-class system with continuous unidirectional operation and relatively stable load. It works indoors with dust, where maximum environmental temperature reaches 55°C. The depreciation period of machine is eight years. There is a major overhaul every four years, a medium repair every two years and a small repair every half year; the allowable error of conveyors speed is ±5%; the machine is produced by general machinery factories with small batch production. Production capacity: 500 kg/h (10 h a day). Tea Bulk density: 165 kg/m^3, the theoretical production value: 3 m^3/s. Since the work in the fermentation workshop is limited by space and other factors, it requires crew size as small as possible. Selecting farming sites B = 1000 mm; raking stack height H = 440 mm; production efficiency Q = 0.5T/h. The forward speed of turning machine can be calculated that:

$$Vm \geq Q/(\rho BH) = 0.5/(165\times1\times0.44) = 0.002 \text{ m/s} \quad (1)$$

Considering the impact of artificial pushing turning machine so taking Vm = 0.05 m/s.

Structural design drum turning machines: Pu'er turning drum machine by turning devices, transport devices, power devices and a rack (Fig. 2).

Turning the drum speed: Turning machine blade motion is complex, the speed of Vo = ω R around the axis is the relative speed, forward speed Vm is convected velocity, blade trajectory endpoints available trochoidal parametric equation solving:

$$AX = Vm+R\cos\omega t \quad (2)$$

$$Y = R\sin\omega t \quad (3)$$

Absolute speed:

$$V = \sqrt{V_m^{\,2} - 2V_mV_0\sin\omega t + V_0^{\,2}} \quad (4)$$

The current data of puer tea is not yet clear. According to conclusions that the average cutting speed

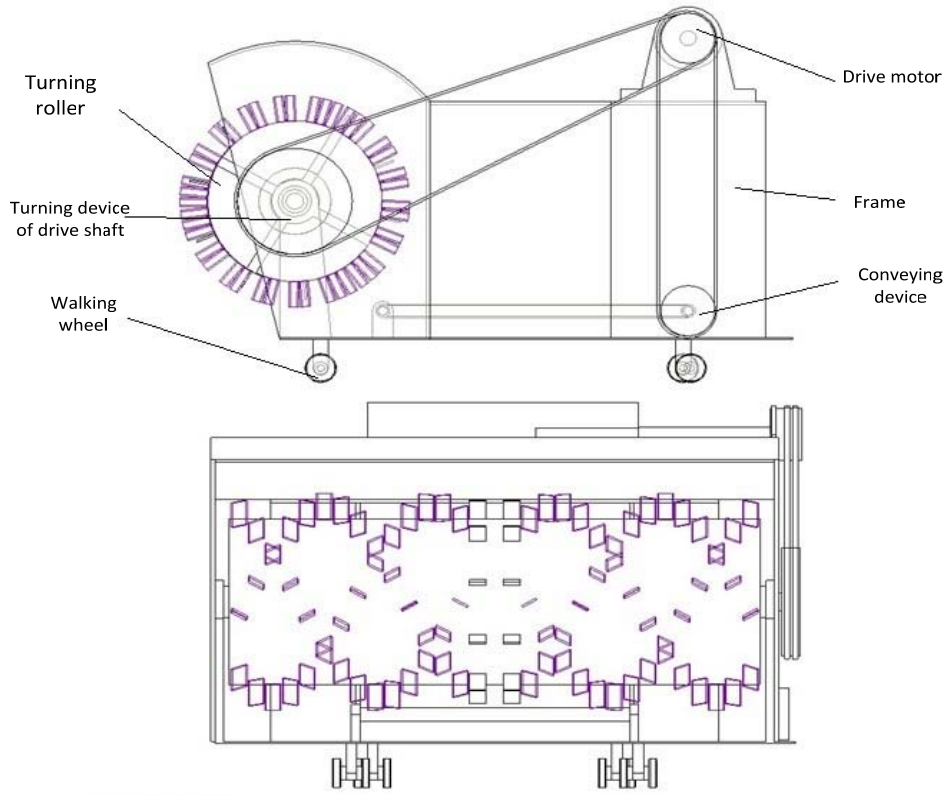

Fig. 2: The structure of turning machine

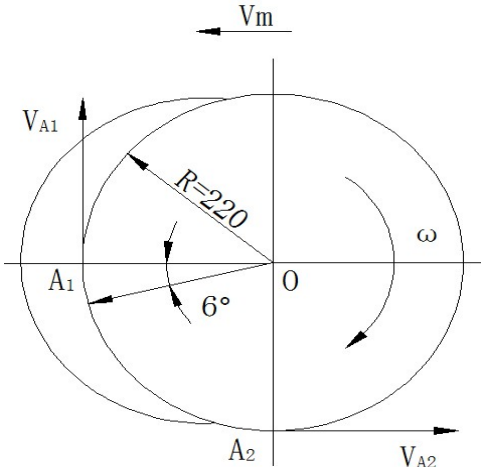

Fig. 3: Turning device operating speed analysis tool schematic

of light and medium soils is around 3-4 m/s and the average cutting speed of prairie marsh clay is about 6-8 m/s, for the situation that tea will be bonded after fermentation finishing, so the average cutting speed selects 4 m/s. Since the turning depth H = 200 mm, drum radius R = 220 mm, Endpointof cutting edge cuts soil from point A along a cycloid and ends cutting at the end of point A, shown in Fig. 3: the corresponding rotation alanglein to the tea stack:

$$\varphi_m = \arcsin(1\text{-}H/R) = 6° \quad (5)$$

Entering point A1 absolute velocity magnitude:

$$V_{A1} = \sqrt{V^2{}_m - 2V_m V \sin\varphi_m + V^2{}_0} \quad (6)$$

The size of the end point of the absolute velocity of A2:

$$V_{A2} = V_0 - V_m \quad (7)$$

Mean absolute cutting speed:

$$V = (V_{A1} + V_{A2})/2 \quad (8)$$

Take V = 4 m/s:

$$4 = (\sqrt{0.05^2 - 2\times 0.05 V_0 \sin 6^0 + V_0{}^2})$$

Available: $V_0 = 4.005 m/s$.

ω = Vo/R = 4.0/0.22 = 18.2rad/s = 173.88 r/min

So the drum speedis: 174 r/min.

RESULTS AND DISCUSSION

Merits of agent-oriented modeling: Agent is an advanced computing, if we compare with the traditional numerical analysis method. It not only provides modeling methods, but also gives solution of the problem. In particular, agent-oriented system may deal with complex interactions between environment and the robot. Now more and more people think that the intelligence of robot is increased in these interactions.

CONCLUSION

This study researches tea fermentation process and turning operations for puer tea and analyzes the process and the design principle of turning machines. According to the actual needs of the tea turning, the power of drum turning machines are calculated and selected. The study makes research and analysis for the arrangement rules and installation location of turning vanes. It designs delivery device and turning drum of drum turning machines and other major mechanical components, as well as stents. This drum turning tea device designed in the study is both economical, reliable and practical, providing research base for the puer tea fermentation production automation.

REFERENCES

Gu, Q., J. Lu and B. Ye, 2002. Tea Chemistry. China Science and Technology Press, Hefei, pp: 180-182.

He, Q.Y. *et al*., 2002. Analysis of organic tea processing technology. Tea Sci. Technol., 158(2): 38-39.

Huang, Y.Z., Y.J. Zhao *et al*., 2012. Development and application of tea fermentation. Food Mach., 161(01): 115-118.

Jiao, Y., G.M. Zhao *et al*., 2010. Design and research peeling style slot machine with turners. Agr. Technol., 63(04): 142-144.

Luo, L.X., X.C. Wu *et al*., 1998. Yunnan puer tea heap relationship changes during its biochemical composition and quality of the formation. Tea Sci., 31(01): 53-60.

Shao, S., Y.L. Li *et al*., 2011. Automated production of tea fermenting developed patented technology. Food Mach., 145(06): 183-185.

Xue, Z.Q., Y.L. Li *et al*., 2012. Progress in the health benefits of tea. China Health Nutr., 59(14): 2449-2451.