The Frontiers of Society, Science and Technology

ISSN 2616-7433 Vol. 1, Issue 4: 266-270, DOI: 10.25236/FSST.20190342

Energy-saving design and equipment research of polymer material forming

Na Wang, Xianyong Zhang

Guangdong Polytechnic Normal University, Guangzhou 510000,China

ABSTRACT. *With the continuous development of China's current social development process, in the process of widespread application of organic matter and polymer materials in production and life, researchers and production companies are gradually upgrading their ability to independently innovate in technology. New breakthroughs have been made in the design of molding technology. This paper studies the energy-saving design concept of polymer material molding technology, briefly describes the necessity and principle of organic polymer material molding technology, analyzes dynamic extrusion and injection molding, and finds multi-screw polymer dynamic mixing and extrusion equipment. The introduction of the vibration force factory ensures that the comprehensive performance of the product is effectively improved, and the molding process is effectively shortened to achieve the energy-saving goal of reducing consumption.*

KEYWORDS: *polymer material molding technology; energy-saving design; equipment*

1. Introduction

The polymer materials used in people's production and life, whether it is cotton, hemp, natural rubber, silk and other natural organic polymer materials, or plastic, chemical fiber, synthetic rubber and other high-molecular materials, in the process of use, Through the corresponding production process and construction technology, the polymer materials are aggregated into certain molding materials[1]. With the continuous innovation and research and development of various emerging technologies, the introduction of energy-saving technologies has achieved the effects of reduced input, increased efficiency, and reduced energy consumption. This paper will focus on the energy-saving design and equipment of polymer materials.

2. Importance and technical principle of organic polymer material molding technology

For organic high-molecular substances, both natural materials and synthetic materials require a certain molding process technology, and materials can be utilized by people's production and life. Therefore, according to the physical and chemical

ISSN 2616-7433 Vol. 1, Issue 4: 266-270, DOI: 10.25236/FSST.20190342

properties of organic polymer materials, the polymer organic materials can be plastically molded by a certain process technology to meet the various needs of people's production and life[2], and it is very important for the processing and utilization of organic materials. In the processing and molding process of organic polymer materials, the basic principles of mechanics and thermals are mainly used to continuously change the shape of organic polymer materials to achieve effective utilization. The polymer fiber, silk, hemp, and the like are spun into a linear molding material by a mechanical device, a manual device, or the like according to the action of the rotational force, and the shape of the woven or braided wire is changed into a sheet-like silk fabric. Polymer synthetic materials like plastics, chemical fiber, synthetic rubber, etc. are greatly affected by temperature. With the increase of temperature, these polymer organic materials will melt and become soft and easy to plastic. People use the thermal principle of heat fusion and condensation to follow Different polymer materials have different heating effects and melting points. The corresponding extrusion, injection molding, blown film and other processes are used to change the shape of organic polymer materials to facilitate the effective use of people in production and life.

3. Dynamic extrusion molding

This article will briefly introduce three types of low-energy dynamic molding technology and equipment:

3.1 Polymer dynamic extrusion molding

The polymer dynamic plasticizing extrusion method is a dynamic molding method in which the vibration of the screw is first introduced into the whole process of plasticizing and plasticizing extrusion by the axial vibration of the screw. In the solid transport process, the vibration-induced solid transport process is similar to the vibration compaction commonly used in civil engineering, that is, the use of the vibration force field to aggravate the relative motion between the solid particles, thereby accelerating the compaction process. In order to explore the mechanism of the vibration force field affecting the solid transport process, we established a mathematical model of the vibration force field enhanced solid transport process with the moving material in the screw groove, and obtained the pressure (density) and velocity of the material transported along the groove direction. Approximate analytical solution, the traditional solid transport process is a special case when the amplitude of the axial vibration of the screw is zero. Theoretical analysis shows that the axial vibration of the screw can increase the average pressure of solid transport, shorten the length of the solid transport section, and increase the solid transport angle. Compress the end of the segment. After the application of the vibration, in the initial stage of the melting stage, the solid bed at the same position of the screw becomes uniform, the degree of compactness is improved, and the end position of the melting section is significantly advanced. In order to analyze the influence mechanism of the vibration force field on the melting process, we established a

ISSN 2616-7433 Vol. 1, Issue 4: 266-270, DOI: 10.25236/FSST.20190342

melting analytical model of the extrusion process under the vibration force field.

3.2 Polymer solution impact experiment

The polymer melt is a typical complex elastic fluid. Experimental and theoretical studies have shown that the introduction of the vibration force field can reduce the melt creep and elasticity. By increasing the strain amplitude or vibration frequency, the polymer melt viscosity decreases, and there is an optimum strain amplitude and an optimum frequency, at which time the polymer melt has the largest decrease in apparent heave[3]. The decrease in the apparent boring of the melt results in a decrease in extrusion resistance and a decrease in extrusion pressure at the same yield. The effect of the vibration force field on the overall performance of the polypropylene extruded product was directly sampled on the extruded PP sheet sample along the vertical and parallel extrusion directions for tensile and impact properties testing. The test results show that after the vibration is applied, the tensile strength of the sample in the vertical and parallel extrusion directions increases first and then decreases with the increase of frequency and amplitude. The impact strength of the sample also rises first and then falls back with the amplitude. The above results show that after the vibration field is introduced, under the same conditions of production, the energy consumption requirement for transport plasticization is reduced, the length-to-diameter ratio of the screw can be reduced correspondingly, and within a certain range of vibration parameters, not only can it be guaranteed, or even It also enhances the overall performance of the product.

3.3 Dynamic injection molding

The dynamic molding method is one of the important application fields of the pulsating pressure-induced injection molding method and equipment. In the pulsating pressure-induced injection molding equipment, the vibration force field is introduced to the whole process of plasticizing, injection filling and holding pressure[4], so that the filling pressure can be reduced by more than 20%, and the processing temperature is lowered by more than 20 °C. For example, the vibration factor is defined, where the amplitude is the vibration angular frequency and the average linear velocity of the screw. The relationship between the filling power of the disk cavity and the vibration factor is obtained through experiments. The introduction of vibration can reduce the filling power by m. Due to the introduction of vibration, the parameters during the injection vary with time. The curve of the filling pressure with time shows that the apparent helium of the melt is reduced and the flow performance is improved by the pulsating pressure. Therefore, under the same injection pressure, the pressure consumed by the same filling distance is reduced. , the performance is higher than the steady state pressure of the cavity. On the other hand, when the filling distance is constant, the average injection pressure required for dynamic injection molding can be correspondingly reduced. Therefore, the dynamic injection molding process improves the flow properties of the melt, improves the mold filling ability of the melt, and can be molded under relatively low

ISSN 2616-7433 Vol. 1, Issue 4: 266-270, DOI: 10.25236/FSST.20190342

temperature and pressure conditions, thereby reducing energy consumption.

4. Multi-screw polymer dynamic mixing and extrusion equipment

The polymer three-screw dynamic mixing extruder creates a method of introducing a vibration force field during the polymer material conveying process to enhance the plasticizing and mixing effect of the material. The device makes the intermediate screw pulsate axially, and the axial inter-tooth engagement gap formed between the screws periodically changes, so that the material is subjected to complicated shearing action and periodic pulsating extrusion grinding during the conveying process.

By simulating the values of the melt mixing and conveying process of the EPDM/PP (15/85) blending system in the metering section of the three-screw dynamic mixing extruder, it was found that [m: dynamic mixing with respect to the steady state process At the same time, the path of the particles staying in the screw extruder increases, so that the melt is subjected to sufficient shear mixing; and as the vibration frequency and amplitude increase, the shear rate, velocity and flow rate of the flow field have a certain degree. The increase, while the mean value and pressure mean of the flow field have a certain degree of decline, combined with the periodic compression and release of pulsating shear and pulsating pressure, making the dispersed phase easier to further refine and evenly dispersed in the continuous phase.

Related experiments show that with the increase of vibration frequency and amplitude, the yield of blends increases to some extent, while the unit consumption decreases. As the vibration intensity increases, the shear mixing effect of the screw increases, the flow field shoe size decreases, the internal friction force is smaller, the flow resistance is smaller, and the power consumed to overcome the friction is reduced, so after the introduction of vibration The unit consumption is reduced compared to the steady-state unit consumption, but the decreasing trend is non-linear

5. Conclusion

This study found that by using the vibration-enhanced screw forming technology, the length-to-diameter ratio of the screw can be further shortened and the energy consumption can be reduced under the premise of ensuring the quality of the product. For injection molding, a cyclically varying pulsating pressure can produce a drag reduction effect, resulting in a reduced mold filling pressure loss and thus can be formed at a lower injection pressure. For the dynamic mixing process, the material and the elasticity are reduced under the action of the vibration force field, and the composite system is subjected to the periodic pulsating extrusion grinding effect, which produces the effect of strengthening the mixing and dispersion, and reduces the power consumption. Therefore, the introduction of the vibration force field energy is not a simple superposition of energy, but the nonlinear characteristics exhibited by the polymer molding process under the action of the

ISSN 2616-7433 Vol. 1, Issue 4: 266-270, DOI: 10.25236/FSST.20190342

vibration force field, reducing the energy consumption of the molding process and improving the product quality. A new molding method for energy saving and consumption reduction.

References

[1] Zhang L Z , Li J M(2018). The Research of Composite Solar and Wind Energy Materials Generator[J]. Advanced Materials Research, no.531, pp.584-588.
[2] Shang L X, Zhou C Y ,Jing Y T(2016) . Research and Design of Energy-Saving and Environmental-Protection Full Evaporative Air Cooler[J]. Applied Mechanics and Materials, vol.3, no.368-370, pp.400-410.
[3] Fang-Fang L(2017). The Design and Application of Electrical Energy-saving in Railway Industry. Journal of Railway Engineering Society, vol.34, no.8,pp.98-103, 108.
[4] Tian J ,Zhao X , Zeng S , et al(2018). Application Research of Slag Grinding Technology and Equipment of Efficient Energy-Saving. Journal of Solid Waste Technology and Management, vol.40, no.1, pp.86-91.