



Comparative study on the display effect of particle animation in gas atomization pulverization equipment

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Abstract. In this paper, aiming at the display method of improving the pulverization process of gas atomization pulverization equipment, through the research on the simulation status of gas atomization pulverization process and the simulation status of particle system method, it analyzes and summarizes the feasibility of particle animation simulation of gas atomization pulverization process. It expounds the key technology of particle animation simulation in the process of gas atomization pulverization, adopts the method of X-Particles, Realflow, TurbulenceFD in C4D, and based on the redshift renderer environment of GPU, realizes the realization of pulverization process. The dynamic simulation of the 3D scene and the comparison of the simulation results of four different pulverizing effects will finally determine the target pulverizing effect, helping users understand the gas atomization pulverizing technology more intuitively and efficiently, thereby improving the commercial value of the gas atomization pulverizing equipment value.

Keywords: Particle animation, Computer graphics, 3D animation, simulation of atomization

1 Introduction

With the rapid development of computer graphics technology, various simulation animations based on particle systems are becoming increasingly popular, such as flame spraying, fluid solubility, gas, smoke, and other animations, which have been widely used in various industries. In recent years, metal and alloy powders have been important raw materials for industries such as metal injection molding (MIM), metal 3D printing, high-temperature alloys, and magnetic materials [1]. There are many methods for preparing metal powders, and atomization is a commonly used method. In the milling process, it is necessary to observe the particle formation and fracture effects in real-time. In short, it is necessary to observe the animation effects of its three-dimensional simulation. However, the current main display method is two-dimensional display, which is difficult to accurately express the milling process.

According to the literature of particle animation display, no relevant research on particle animation display in the process of atomization pulverization has been found.

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Therefore, this paper describes the current status of particle animation, looking for various kinds of research particle animation display literature, this paper based on C4D X-Particles, Realflow, Turbulence FD plug-in, in order to meet the requirements of real-time and fidelity of the simulation and its application in the demonstration of the atomization pulverization technology, the different effects of the atomization pulverization process are simulated, in order to enhance the commercial value of the gas atomization pulverization equipment, it is necessary to add color to the virtual display propaganda.

2 Related Research Status

2.1 Research on the simulation of gas atomization pulverization process

In recent decades, computer simulation animation has been a hot research. Therefore, it is necessary to apply the research hotspot in the atomization pulverizing equipment. Zeoli et al combined TAB model and KH model to describe the critical breakup and solidification process of droplet, and combined this model with the results of gas atomization flow field to analyze the whole process of atomization pulverization [2]. Aiming at the rapid solidification process of droplet, Wang Liqing et al used Fluent software to simulate the heat transfer process between atomized gas and alloy droplet, and revealed the rule of solid and liquid phase distribution in the rapid solidification process of droplet [3].

The simulation study of atomization pulverization in the literature above is relatively simplified, only a few involve the melting of the parent alloy or the cooling and solidification of the powder. What they study is a detailed analysis of a certain part by means of physical or mathematical models, it does not pay attention to its display effect, and this paper is different from the simulation, this paper is mainly the use of particle animation of its powder process for animation effect display.

2.2 Current status of particle system simulation

At present, many scholars have used particle system to simulate some real scenes and scenes successfully, and most of them are based on the combination of physical model and particle system. Foster proposed a three-dimensional simulation approach to the study of liquid mixing models, which has contributed significantly to the development of water-based simulations [4]. Luo Ting et al use Mel language to make particle effects animation, such as large-scale characters, scenes and special effects design [5]. Based on the smoothed particle hydrodynamics (SPH) method, Shao and his colleagues proposed a computational model of adaptive fluid velocity control force considering topographic differences, and established a stable SPH-swe numerical model, the problem of particle accumulation and scattered motion of fluid in complex terrain is solved effectively [6], and Josstam et al use knowledge of thermodynamics to simulate gas motion such as flame and smoke [7].

The above documents all use physical models or physical knowledge to simulate various particle effects, which is relatively complicated. Therefore, this article will use the particle system in C4D to simulate the gas atomization pulverization process.

3 Particle animation simulation of gas atomization process feasibility analysis and advantages

3.1 Feasibility analysis of particle animation simulation of gas atomization pulverization process

The basic principle of gas atomization is to make use of the high-speed air flow to impact the molten metal, which changes the kinetic energy of the gas into the surface energy of the molten metal by collision, and makes the molten metal flow into tiny droplets, it then rapidly cools and solidifies into powder in the air stream, as shown in Figure 1.

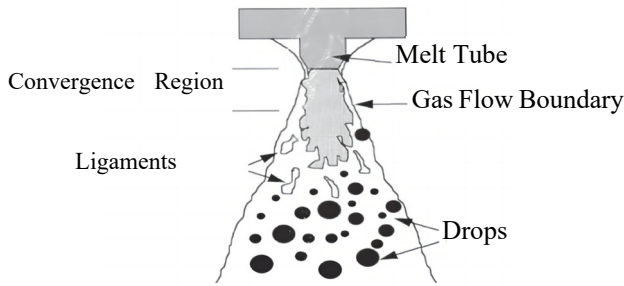


Fig. 1. principle diagram of gas atomization pulverization [8]

The whole atomization pulverization process is very complex, the existing simulation is only through some physical models and algorithms of atomization pulverization process at different stages of simulation analysis, there is no rendering effect display. At present, there is no relevant research for the gas atomization process of animation effect display.

In order to facilitate the simulation animation of the gas atomization milling process in this paper, consult the literature of Dombrowski et al. [9], it is found that the metal melt is driven by high-speed gas, first becomes a liquid film, then extends into a wavy shape, and then further breaks into drops, as shown in Figure 2, and the gas atomization powder making process is tested and numerically analyzed, and the diameter of the ribbon melt is related to the thickness and wavelength of the liquid metal film, as shown in the following formula, where λ is the wave wavelength and S is the thickness of the molten metal film:

$$d_L = 3(\lambda S)^{\frac{1}{2}} \quad (1)$$

According to formula (1) and literature experiment analysis, the motion blur of molten metal in the process of gas atomization pulverization is a kind of fuzzy phenomenon, with strong uncertainty and complexity, so the difficulty of its simulation is relatively high. The particle system has a sense of reality that other methods cannot match in simulating animations such as smoke, flames, fluids, and gases. In order to improve

the publicity image and commercial value of the virtual display of the gas atomization powder making equipment, and by observing Figure 2, we can know that it is feasible to use the particle system to simulate the animation of the atomization powder making process in this paper.

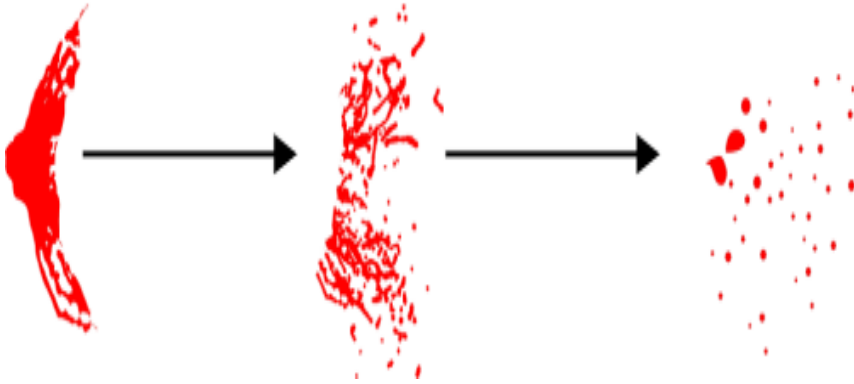


Fig. 2. Schematic diagram of melt atomization crushing

3.2 Advantages of Particle Animation Simulation of Flour Making Process

At present, the mainstream display methods of the metal atomization pulverization process are two-dimensional, which is relatively simple, and it is difficult to show the commercial value and image of the enterprise. However, using the particle system method to simulate the milling process can better express the milling effect and process, and the thinking is clear and easy to implement. The particle system method can help people deal with the pixels in computer graphics and the relationship between them, and the operator can easily adjust and modify the animation of the milling process according to the actual effect.

4 The key technology of particle animation simulation in the process of atomization pulverization

4.1 The overall structure of animation simulation of atomization pulverization process

As shown in Figure 3, during the development and modeling process, the model of the gas atomization pulverization equipment is established through Rhino, the model data is converted into C4D format, the object display list is established, the pulverization method is selected, and colors, materials, textures, lighting, backgrounds, etc. are added. Elements, adjust the transformation of projection and viewport, and create a 3D animation scene of the atomization and pulverization process.

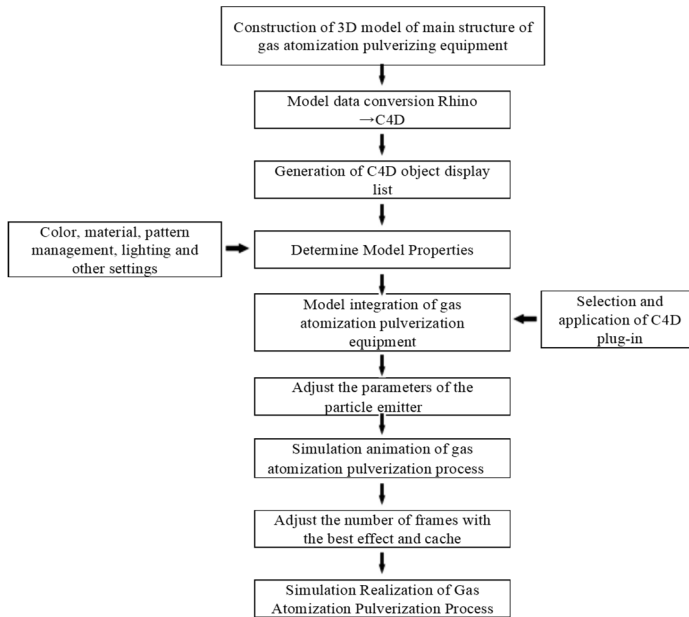


Fig. 3. Overall block diagram of animation simulation of milling process

4.2 Selection and application of C4D particle plug-in

X-Particles provides full control over particle simulations, improving the visuals of particle effects animations. The RealFlow plug-in can simulate the flow and collision effects of many liquids, and can be better compatible with C4D models, modifiers, dynamics modules, particle effects and other functions, and can achieve various fluid effects. TurbulenceFD is a plug-in for simulating fluid, smoke, fire, ink and other effects. Based on the above plug-ins, in the process of making the video animation of the atomization powder making equipment, the powder making animation is a very complicated animation process, and it is difficult to realize the visual effect display. However, the plug-in technology in this paper provides the possibility of computer graphics animation macro simulation display of its process.

1. Animation Realization of Gas Atomization Pulverization Process.

In the pulverization animation of gas atomization pulverization equipment, the animation of liquid flow breaking and droplet solidification is a very important part of the display. Referring to the traditional animation design method, the display effect cannot be achieved. Therefore, based on the effect in Figure 2 and formula (1), through the C4D plug-in tool, the animation production method of the smoke and fluid plug-ins, the animation display effect of this part is realized. According to the system structure diagram, the animation effect is simulated as shown in Figure 4. Compared with the traditional technology, this method simulates more realistically and can see the effect in real time, which improves the efficiency of animation production.

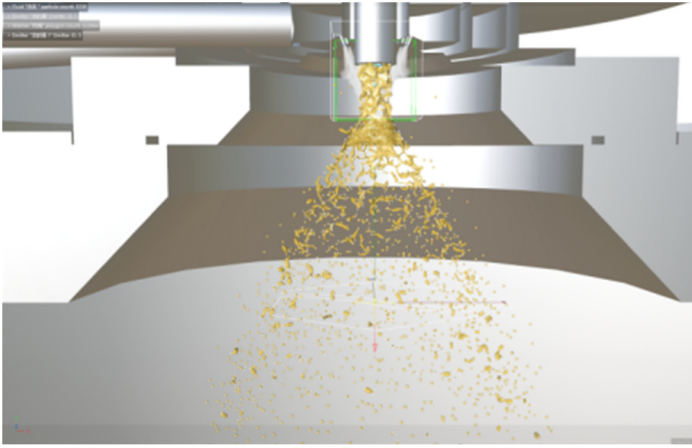


Fig. 4. Screenshot of simulation of milling process (initial effect)

4.3 GPU rendering technology based on Redshift renderer

Redshift renderer is an excellent renderer that is very compatible with 3D software such as C4D. In order to solve the simulation efficiency and realism problems in the process of atomization and pulverization, the Redshift renderer GPU rendering technology is used to simulate the animation of the entire pulverization process. The scene is rendered. GPU rendering can instantly display the rendering effect, quickly preview the rendering effect, and see the changes of materials and lighting.

5 Comparison of digital display effects of gas atomization pulverization process

5.1 Experiment and Discussion

In the process of experimental simulation, this paper adjusts various parameters during simulation, uses Redshift renderer to render the simulation results offline to achieve the best effect, and then compares and discusses with the simulation effects in some literatures and the real effects of milling, so as to further Verify the authenticity of the simulation effect in this paper.

1. Simulation results.

Figure 5 is a screenshot of the rendering effect simulation process of the milling process. In the virtual rendering scene, the process of atomization and milling can be seen from different perspectives, realizing the three-dimensional effect display of the milling process.

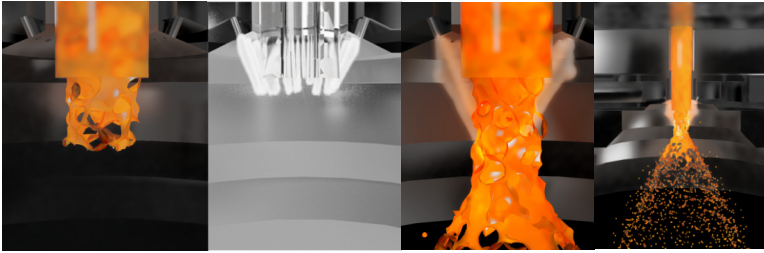


Fig. 5. Rendering of the animation process of each part of the atomization pulverization process

In the simulation experiment of gas atomization pulverization, the pulverization effect can be adjusted by modifying relevant parameters. Opens its fluid editor, where particle density and type can be modified. There are three types that conform to the experimental comparison of the powder making effect in Figure 5, and the effect diagram after modifying the particle type is shown in Figure 6.

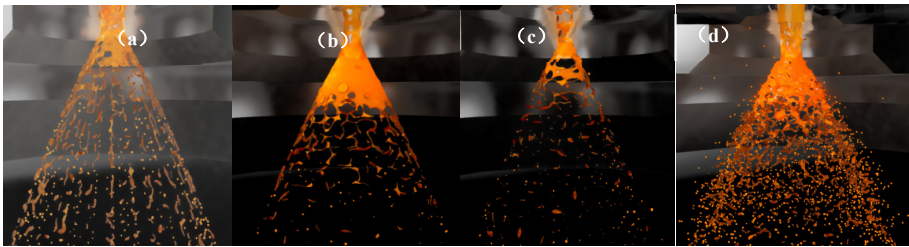


Fig. 6. Comparison of experiment types

In order to ensure the validity of the experiment, the parameter of particle density used in the simulation experiment of the above milling process is 3000, and the parameter of type resolution is 3. In the comparison results, although the particles in Figure 6 (a) fall randomly, but it still has a certain regularity. The particle flow in Fig. 6(b) is too smooth, and they are all one-piece or filamentous. The particles in Figure 6 (c) are too broken, which is still quite different from the real milling effect. The effect of simulated powder making in Fig. 6(d) is more realistic. The simulated particles are both irregular and irregular, and it also reflects the process of temperature change from droplet spraying to powder collection.

2. Simulation result analysis.

The density and type of aerosolized powder particles are different, and the rendering effect of animation display is also different, that is to say, the type and quantity (ie density) of atomized powder particles directly affect the efficiency of animation drawing. From the simulation results, it can be seen that the particle animation simulation effect of the gas atomization pulverization process has a certain sense of reality. From the analysis of simulation results, it can be seen that the three-dimensional display effect of atomized pulverization in Figure 6(d) is in line with the expected display effect of this paper and can meet our visual requirements.

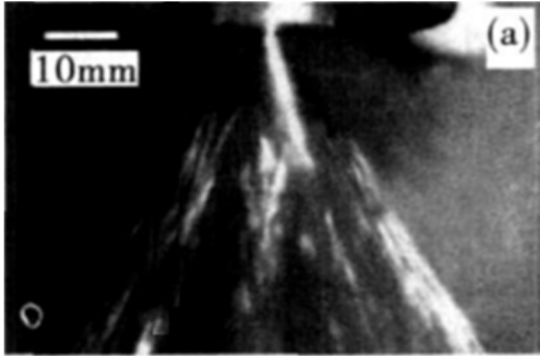


Fig. 7. Photos taken at high speed during the atomization pulverization process.

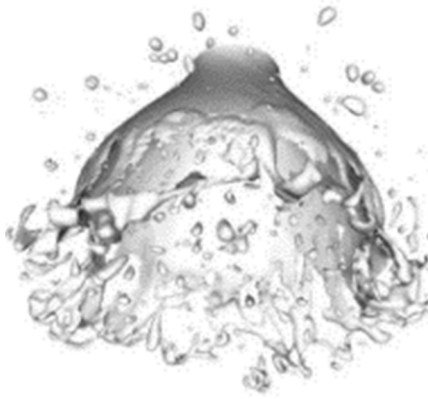


Fig. 8. Screenshot of partial effect display in the literature by KunLuo et al. [10]

After observation and analysis, it is found that in the current gas atomization powder making equipment, the three-dimensional animation simulation to show its powder making effect is immature, and the powder making effect shown in this paper is compared with the effect of the photo in Figure 7 and the effect in Figure 8, is more realistic. From a macro point of view, the effect of this article not only reflects the fluidity of molten metal and the irregular graininess of metal powder, but also clearly sees the temperature change of molten metal from spraying to powder falling.

6 Conclusion

Aiming at how to improve the traditional display method of the pulverization process of gas atomization pulverization equipment, this paper uses X-Particles, Realflow, TurbulenceFD in C4D, and the redshift renderer environment based on GPU to efficiently realize the dynamic simulation of the 3D scene of the pulverization process, to elevate the animation display effect to a new level. And by comparing the experimental results of four different milling effects, the milling effect is finally determined to help users

understand the gas atomization milling technology more intuitively and efficiently, thereby improving the commercial value of the gas atomization milling equipment. However, the milling effect animation produced in this paper is displayed from the macroscopic aspect, and the real-time performance is limited to a certain extent. Improving the real-time animation and restoring the details such as melting and mixing real microscopic particles are important contents for future research.

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