doi: 10.18323/2782-4039-2024-4-70-4

Study of centrifugal atomisation mechanisms based on a simulated experiment

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Received 15.02.2024 *Revised 16.04.2024* *Accepted 28.10.2024*

Abstract: The process of melt dispersion on a rotating bowl is a common method for producing metal powders. It is difficult to study the dispersion process on real melts, including by visualisation methods. Therefore, it is proposed to study the influence of such factors as the jet fall height, liquid flow rate, surface wetting, and the presence of a bowl wall on the process of obtaining small droplets using a model liquid without crystallisation, recording the process by high-speed shooting. The purpose of this work is to determine the most favourable dispersion conditions, when all the supplied liquid turns into droplets without the formation of large droplets, additional jets leading to secondary spraying. A glycerol solution in water with a viscosity equal to the viscosity of tin melt was chosen as a model liquid. The dispersion process was shot on a high-speed camera with a shooting frequency of 1,200 frames per second. It was found that when increasing the melt flow, a change in the spray mode is observed. With an increase in pressure, the flow and kinetic interaction of the jet with the surface of the bowl, increase, and consequently, the excess liquid, which is sprayed prematurely, increases. At any flow of the supplied liquid, if the liquid does not get to the centre, secondary spraying occurs due to the destruction of the film, on the hydraulic jump, because of the uneven radial velocity at the peak of the jump. When the feed height changes from 100 to 150 mm, secondary spraying in the form of droplets is observed at the hydraulic jump area. The number of spirals and secondary spraying affect the increase in the size of the particle fraction. In the range of the jet fall height from 50 to 100 mm, an optimal process is observed, in which it is possible to obtain the smallest fraction. In the experiment, a tendency to improve the spraying process when increasing the bowl surface finish was observed. Due to the walls of the bowl, the path of the liquid before it leaves the bowl increases, drops flying above the surface of the bowl are destroyed into a film, therefore, the dispersion process improves.

Keywords: centrifugal melt atomisation; melt dispersion on a rotating bowl; liquid flow; metal powder; hydrodynamic conditions; high-speed shooting.

For citation: Zhukov E.Yu., Naurzalinov A.S., Pashkov I.N. Study of centrifugal atomisation mechanisms based on a simulated experiment. *Frontier Materials & Technologies*, 2024, no. 4, pp. 39–49. DOI: 10.18323/2782-4039-2024-4-70-4.

INTRODUCTION

Centrifugal melt atomisation (CMA) is one of the common methods for producing metal powders by dispersing the melt. Compared to spraying the melt with gas or water, CMA has a narrower range of particle sizes, which gives great advantages to this method in terms of yield. The essence of the method is to destroy the melt under the action of centrifugal forces on a rotating bowl. In this case, the melt can be supplied to the bowl in the form of a jet, films, and drops [1]. In any case, a liquid film is formed on the surface of the bowl, which turns into drops on the edge of the rotating bowl. The CMA method is limited to producing materials with a low melting point. This is mainly associated with the necessity to ensure that the melt wets the surface of the bowl, and makes it resistant to the effects of the melt. For high-temperature alloys, centrifugal atomisation of a rotating rod is usually used.

The process of obtaining metal particles of a given size is affected by the hydrodynamic conditions of the liquid dispersion process, and the thermal conditions associated with cooling and solidification of the melt. To obtain a given powder particle size, it is necessary first to ensure the supply of a liquid jet to the bowl, its distribution over the surface and dispersion into particles of a certain size. Simultaneous solution of the problems of studying hydrodynamic and thermal processes is cumbersome and difficult, so it makes sense to study them separately.

Analysis of literary sources on CMA shows that the main attention is paid to the problems of the influence of the liquid flow nature, the disk design and the spraying parameters on the fractional composition of the resulting powder. It is noted that the rotation speed of the bowl mainly determines the size of the resulting powder. To obtain highly dispersed powders, it is necessary to select an electric motor with a rotation frequency of 10,000 rpm [2; 3].

One of the most important parameters during spraying is achieving a certain liquid flow [4; 5]. During centrifugal atomisation, molten metal wets the disk and flows to the disk periphery, where it forms a liquid torus. The instability caused by the disk rotation creates small bundles at the disk edges, which are then thrown off the disk in the form of droplets. At high liquid feed rates, bundles may not form, and the film disintegration mode will occur [6–8]. At low liquid feed rates, droplets can form directly at or in front of the disk edge due to incomplete wetting of the disk [9–11]. In [12], the atomisation process is described when the flow changes from 3 to 10 kg/h; as the flow increases, three mechanisms of liquid atomisation at the bowl edge are observed: droplets, streamlets, and film.

At high rotation speeds, the so-called hydraulic jump often occurs on the bowl [13–15]. A hydraulic jump is an annular jump in the flow, which manifests itself in a sharp increase in the melt thickness, and accordingly, a decrease in the radial velocity, as well as in the separation of liquid particles before reaching the edge of the bowl [13–15].

In [16; 17], it is shown that there is a certain optimal distance from the liquid source to the bowl, at which the powder of the smallest fraction is obtained. If this distance is deviated, the powder size increases, or the range of the fractional composition of the particles expands.

Many sources note that it is necessary to ensure good wettability of the bowl surface with the metal melt [18; 19]. To achieve this, it is even proposed to use a bowl with a coating, the composition of which is similar to the composition of the sprayed material. In this case, good wetting was achieved [19]. For maximum wetting of the bowl surface with the melt during spraying, the bowl can be pre-tinned with the sprayed material. The bowl surface finish affects the adhesion of the melt. A tendency to improve the spraying process when increasing the bowl surface finish is observed. In real processes of metal dispersion on a rough surface, as shown in [20], metal sticks to the bowl surface and solidifies in the form of a torus. On the treated surface, the liquid film will be distributed over the bowl more evenly.

The work [21] describes the effect of bowl slope angle on the size of the resulting particles. The higher this angle, the finer the powders that can be obtained. The finest powder was obtained at an angle of 60–70°. There are no experimental data on the angle of the bowl inclination of 90° [21]. The work [10] shows a decrease in the powder fraction with a bowl with sloped wall. Due to the walls, the path of the liquid before it exits the bowl increases, and as a result, the film decreases closer to the bowl edge.

Therefore, the existing experimental data or calculation models consider the influence of various factors of the dispersion process only on the size of the resulting product, the conditions for maintaining the stability of the process itself are not taken into account. The important role of hydrodynamic processes is noted, but there are no descriptions of the behaviour of a liquid jet when it hits a rotating bowl, turning it into a film with subsequent destruction into drops. The phenomenon of secondary dispersion of large drops and liquid fragments, which have a different speed compared to the film on the bowl, is not considered as well. Therefore, it is of interest to visualise the dispersion process of a model liquid, without taking into account the solidification processes using high-speed shooting.

The purpose of this work is to determine the most favourable dispersion conditions, when all the supplied liquid turns into drops without the formation of large drops and additional jets leading to secondary spraying.

METHODS

The experiments on dispersion on a rotating bowl were carried out with a model liquid. A glycerol solution in water in a ratio of 60/40 was chosen as a model liquid, the viscosity of which corresponded to the molten tin viscosity. The experiment did not take into account supercooling and solidification of melts in real processes. Only the hydrodynamics of the liquid behaviour was studied. The entire process proceeded in air.

To carry out the experiment, a special facility was created consisting of a high-speed rotation drive, a bowl, and a liquid feed device. The rotation drive was rigidly fixed to a massive body. The spraying bowl had a diameter of 36 mm. Liquid was fed to the surface of the bowl through a 50 ml syringe. The liquid feed rate was changed using the pressure in the syringe, equal to 1, 2 and 4 atm, and the needle diameter of 0.8 and 1.5 mm. The diagram of the facility is shown in Fig. 1.

The rotation speed of the bowl was chosen constant, equal to 10,000 rpm. The height of the liquid feed varied from 20 to 150 mm. The bowl slope angle was 0° and 90°.

The experiments were carried out under conditions of complete wetting of the bowl surface with liquid. To obtain a non-wetting mode, synthetic rubber was applied to the spraying bowl.

The experiment considered three types of bowls: smooth (the working surface of the bowl was polished with abrasive paper with a grain size of 800), rough (achieved using paper with a grain size of 40), and without processing (there are traces of a cutter).

The shooting was carried out using a high-speed Casio EX-F1 camera at a shooting frequency of 1,200 frames per second. The formation of a thick film on the surface of the bowl, secondary formation of jets and premature atomisation of liquid were considered to be incorrect centrifugal atomisation conditions.

To determine the values of the hydraulic jump radius R_j and the height of the liquid film H, the following equations were used [9]:

$$R_c = 0.55\left(\frac{\rho Q^2}{\mu\omega}\right)^{\frac{1}{4}},$$

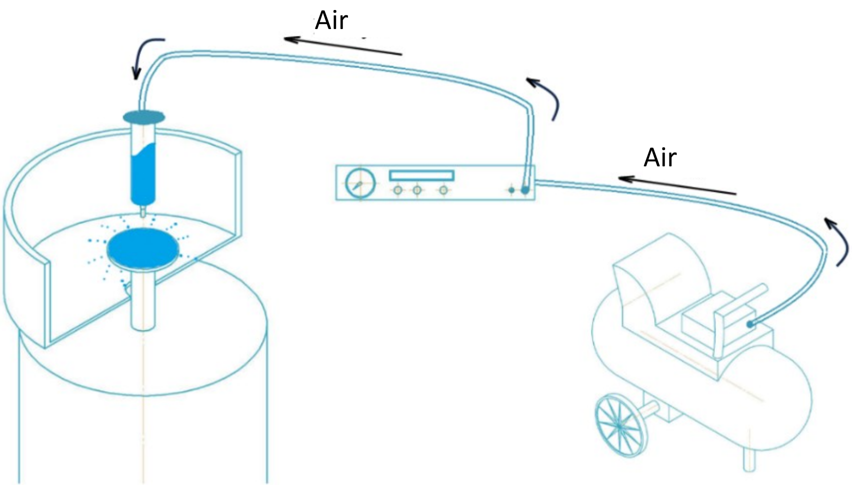


Fig. 1. *Diagram of the centrifugal atomization process*
Рис. 1. *Схема процесса центробежного распыления*

where ρ is the density of the liquid, kg/m^3;
Q is the volumetric flow rate, m^3/s;
μ is the dynamic viscosity, Pa·s;
ω is the rotation speed of the bowl, rad/s;

$$H=\left[\frac{3\,\mu Q}{2\,\pi\rho\,\omega^2 r^2\cos\alpha}\right]^{\frac{1}{3}},$$

where r is the radius of the bowl, m;
α is the angle of inclination of the bowl.

RESULTS

Liquid behaviour at the moment of contact with a rotating disk

When liquid is in contact with a rotating bowl, a disk volume of liquid is formed around the jet, which then stretches to the periphery. When the jet hits the centre of the rotating bowl, a quiet stretching of the film to the periphery and spraying at the bowl edge is observed. When the jet deviates from the bowl centre, large fragments appear that elastically bounce off the surface forming large drops. Premature spraying of the liquid occurs.

Increasing the distance to the bowl leads to a violation of the continuity of the jet, its disintegration into parts, and an increase in the probability of deviation from the centre, as a result – the appearance of premature spraying at the moment of contact with the bowl surface (Fig. 2).

When changing the surface roughness, we can observe that the higher the purity of the bowl surface, the more evenly the liquid is distributed over the bowl surface (Fig. 3).

Liquid behaviour on the bowl surface during the steady-state rotation process

Changing the liquid flow. Calculation of liquid flows for different needle diameters and pressures, as well as hy draulic jump radii and film thicknesses, showed that with an increase in melt flow from 3.96 to 42.35 kg/h, the hydraulic jump radius increases approximately 3 times –

a ***b*** ***c***

Fig. 2. *Changing the height of liquid feed from the bowl at a flow rate of 6.69 kg/h and smooth bowl processing:* ***a*** *– 20 mm;* ***b*** *– 50 mm;* ***c*** *– 150 mm*
Рис. 2. *Изменение высоты подачи жидкости от чаши при потоке 6,69 кг/ч и гладкой обработке чаши:* ***a*** *– 20 мм;* ***b*** *– 50 мм;* ***c*** *– 150 мм*

from 1.83 mm to 6 mm. At the same time, the liquid film height, according to calculations, increases only 2 times – from 0.34 to 0.62 mm (Table 1).

With a constant supply of liquid to the bowl with a needle diameter of 0.8 mm (Fig. 4), and a pressure of up to 2 atm., the formation of spirals on the surface was observed. Spraying occurred along the trajectory of these spirals. There was a shortage of liquid flow for its distribution over the entire bowl surface. When the pressure exceeds 2 atm., due to an increase in the jet velocity, secondary spraying in the form of directed streams occurs to the bowl edge.

With a needle diameter of 1.5 mm (Fig. 5) and a pressure of up to 2 atm., an almost smooth film surface is observed on the bowl with small spirals, and spraying is carried out along the entire periphery of the bowl, and along the spirals. The film thickness on the surface is greater than with a needle diameter of 0.8 mm. With an increase in pressure of more than 2 atm., there are no spirals on the surface, and the spraying itself is carried out only through the bowl edge. Thus, with an insufficient liquid flow, spiral flows are formed, which are sprayed on the bowl edge or up to it. With a sufficient flow, a continuous film of liquid is observed, which is completely sprayed on the bowl edge. An increase in the flow leads to an increase in the film thickness, and therefore, the particle size.

Changing the liquid feed height. If we change the height of the liquid feed to the bowl at a low flow rate of 6.69 kg/h, it is clear that the smaller the distance to the bowl, the more uniform the layer is formed on it, however, spirals are observed that converge at a distance of up to 50 mm (Fig. 6). Along the trajectory of these spiral formations, spraying in the form of streams can be observed at the bowl edge. It is assumed that the main spraying in this case will occur through these streams. At a jet feed height of 100 to 150 mm, double spraying was observed (Fig. 6).

Influence of wetting of the bowl surface. Almost complete non-wetting of the surface was achieved (Fig. 7). During the experiment, various options for treating the bowl surface were tested: applying oil, wax

a *b*

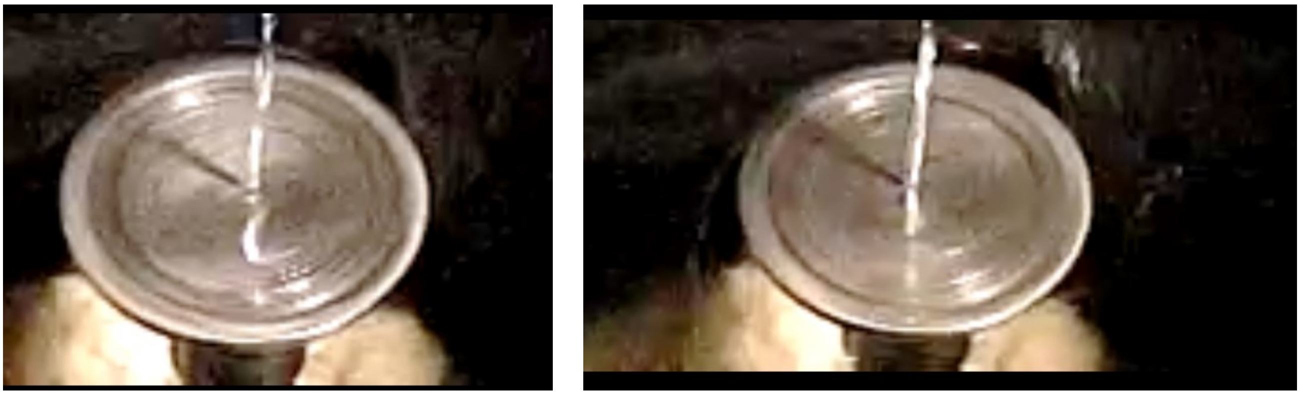
Fig. 3. *Changing the surface roughness at a flow rate of 6.69 kg/h and a distance to the bowl of 50 mm:*
a *– a smooth bowl;* ***b*** *– a bowl without treatment*
Рис. 3. *Изменение шероховатости поверхности при потоке 6,69 кг/ч и расстоянии до чаши 50 мм:*
a *– гладкая чаша;* ***b*** *– чаша без обработки*

Table 1. *Calculation of liquid parameters during centrifugal atomization*
Таблица 1. *Расчет параметров жидкости при центробежном распылении*

Needle diameter, mm	Pressure, atm.	Flow rate, kg/h	Hydraulic jump radius, mm	Film height, mm
0.8	1	3.96	1.83	0.34
	2	6.69	2.38	0.39
	4	9.25	2.80	0.42
1.5	1	21.18	4.24	0.52
	2	34.45	5.40	0.59
	4	42.35	6.00	0.62

a *b*

Fig. 4. *Changing pressure when liquid is supplied to the surface of the bowl without treatment, needle diameter is 0.8 mm:*
a *– 1 atm.;* ***b*** *– 2 atm.*
Рис. 4. *Изменение давления при подаче жидкости на поверхность чаши без обработки, диаметр иглы 0,8 мм:*
a *– 1 атм.;* ***b*** *– 2 атм.*



a *b*

Fig. 5. *Changing pressure when liquid is supplied to the surface of the bowl without treatment, needle diameter is 1.5 mm:*
a *– 1 atm.;* ***b*** *– 2 atm.*
Рис. 5. *Изменение давления при подаче жидкости на поверхность чаши без обработки, диаметр иглы 1,5 мм:*
a *– 1 атм.;* ***b*** *– 2 атм.*

a *b* *c*

Fig. 6. *Changing the distance from the needle to the smooth surface of the bowl:*
a *– 50 mm;* ***b*** *– 100 mm;* ***c*** *– 150 mm*
Рис. 6. *Изменение расстояния от иглы до гладкой поверхности чаши:*
a *– 50 мм;* ***b*** *– 100 мм;* ***c*** *– 150 мм*

and other materials, that were not wetted by the experimental solution. However, at bowl rotation speeds of 10,000 rpm, the model liquid washed away the applied layers. In our case, with a constant supply of liquid through a 0.8 mm diameter needle, a decrease in the number and size of spirals is observed on the non-wetted surface. Only after 4 atm., premature spraying of liquid through streams occurs at the moment of liquid entry, and these streams are not formed immediately after the start of liquid supply to the bowl (Fig. 8).

Changing the bowl geometry. Experiments were carried out with a 0.8 mm diameter needle. On the smooth surface of the bowl, the liquid is distributed more evenly, and the film becomes thinner, unlike the bowl without treatment. The nature of the spirals and streams remain unchanged when the pressure changes for these types of bowls (Fig. 9). If the surface roughness is increased by coarse abrasive treatment, then the spraying process deteriorates, both at the initial moment of contact of the liquid with the bowl and during the steady-state process (Fig. 10). It is obvious that the rough surface of the bowl introduces strong disturbances into the liquid flow, leading to its destruction in the form of streams and drops of different sizes.

In the absence of sloped wall, secondary spraying is observed in the form of drops that fly at an angle to the surface of the bowl. The bowl slope angle of 90° ensures the distribution of large streams and drops of liquid that fall as a result of secondary spraying over its surface, and their spraying on the edge of the bowl. Thus, the proportion of secondary spraying decreases in the presence of sloped wall, and the process becomes more stable.

With a needle diameter of 1.5 mm, the size of the film sprayed from a bowl with sloped wall decreases, in contrast to a bowl without sloped wall. On the surface of the bowl, a liquid film is formed similarly to a bowl without sloped wall (Fig. 11).

DISCUSSION

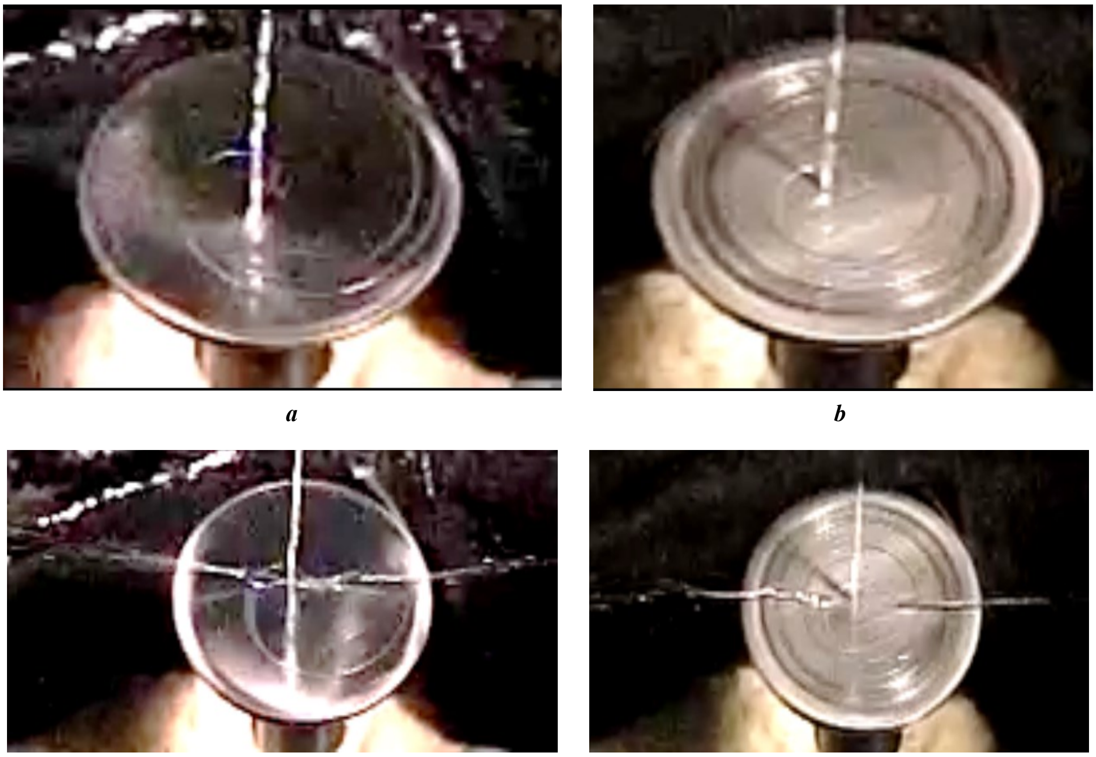
Liquid behaviour at the moment of contact with a rotating disk

When a jet hits the centre of a rotating bowl, the liquid enters a region with zero radial velocity. It spreads over the bowl surface with a constant increase in velocity as it moves away from the centre. When the jet hits at some distance from the centre, part of the liquid spreads over

Fig. 7. *A drop of water on a non-wetted surface*
Рис. 7. *Капля воды на несмачиваемой поверхности*

a ***b***

Fig. 8. *Changing pressure when supplying to a non-wetted surface of a bowl:*
a *– 1 atm.;* ***b*** *– 4 atm.*
Рис. 8. *Изменение давления при подаче на несмачиваемую поверхность чаши:*
a *– 1 атм.;* ***b*** *– 4 атм.*



a b

c d

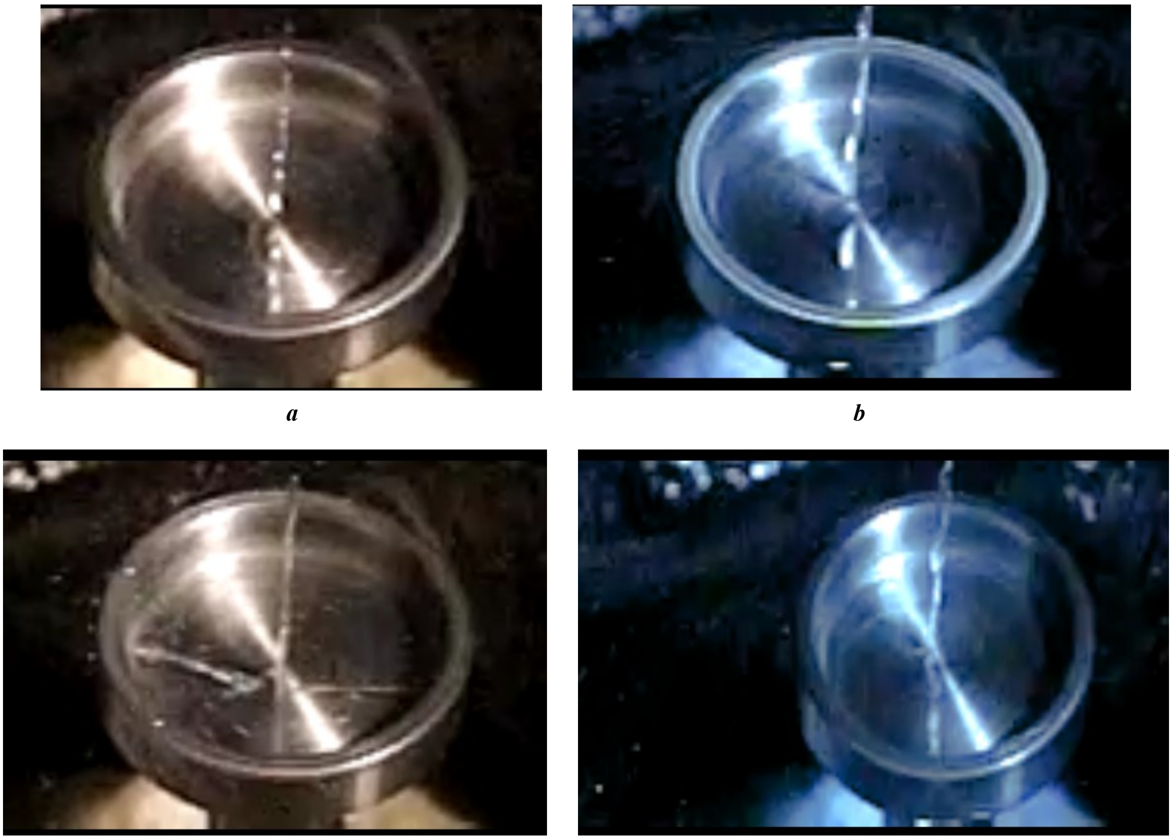
Fig. 9. *Changing the pressure of the liquid supplied to the bowl:*
a *– 1 atm., smooth bowl surface;* ***b*** *– 1 atm., untreated bowl surface;*
c *– 2 atm., smooth bowl surface;* ***d*** *– 2 atm., untreated bowl surface*
Рис. 9. *Изменение давления подаваемой жидкости на чашу:*
a *– 1 атм., гладкая поверхность чаши;* ***b*** *– 1 атм., поверхность чаши без обработки;*
c *– 2 атм., гладкая поверхность чаши;* ***d*** *– 2 атм., поверхности чаши без обработки*

a b

Fig. 10. *Changing the pressure of the liquid supplied to the rough bowl surface:* ***a*** *– 1 atm.;* ***b*** *– 2 atm.*
Рис. 10. *Изменение давления подаваемой жидкости на шероховатую поверхность чаши:* ***a*** *– 1 атм.;* ***b*** *– 2 атм.*

the bowl surface, and part elastically bounces off in the form of large fragments that have a lower speed than the particles from the edge of the bowl have. This part of the liquid does not disperse into small droplets due to a lack of energy. It can be assumed that such premature spraying can lead to the appearance of large powder particles during melt spraying.

Literary sources do not provide a division of the process into the initial (the moment the jet touches the bowl) and steady-state. This is mainly related to the fact that the fractional composition of the resulting powder is usually used to evaluate the spraying process. In general, at the initial stage, all factors that play a decisive role in



a *b* *c* *d*

Fig. 11. *Changing the pressure and needle diameter when spraying liquid on a bowl with sloped wall:*
a *– diameter is 0.8 mm, pressure is 1 atm.;* ***b*** *– diameter is 1.5 mm, pressure is 1 atm.;*
c *– diameter is 0.8 mm, pressure is 2 atm.;* ***d*** *– diameter is 1.5 mm, pressure is 2 atm.*
Рис. 11. *Изменение давления и диаметр иглы при распылении жидкости на чаше с бортами:*
a *– диаметр 0,8 мм, давление 1 атм.;* ***b*** *– диаметр 1,5 мм, давление 1 атм.;*
c *– диаметр 0,8 мм, давление 2 атм.;* ***d*** *– диаметр 1,5 мм, давление 2 атм.*

the steady-state process are important: the distance of the jet feed [16; 17], the flow rate, wetting of the bowl surface [19]. Increasing the height of the jet fall leads to its partial destruction, and the possibility of elastic reflection of part of the liquid. The appearance of large drops when liquid hits a rough surface is associated with strong disturbance, that occurs when the liquid flow hits the rough surface. Reducing the roughness promotes the formation of a stable film on the bowl surface.

Liquid behaviour on the bowl surface during the steady-state rotation process

Changing the liquid flow. One of the important conditions for liquid dispersion from the bowl edges is the correspondence of its flow to the conditions for the formation of a continuous layer on the bowl surface. Otherwise, sources of secondary spraying appear. Depending on the flow, and the distance to the bowl, a hydraulic jump in the form of a ring of liquid is formed. At the hydraulic jump, the film ruptures due to excess liquid and then develops into jets, which corresponds to the data of work [10]. At any liquid flow, if it does not enter the centre, secondary spraying occurs caused by the film destruction at the hydraulic jump, due to the uneven radial velocity at the peak of the jump.

In the literature, there are no descriptions of the formation of spiral flows on the bowl surface. Their formation is obviously associated with a lack of liquid to fill the entire surface of the bowl. In this case, the liquid should have spread into a very thin layer, so the surface tension led to the formation of spiral flows. In this case, spraying was always observed at the exit of the spirals to the edge of the bowl. It was mostly in the form of droplet spraying. As the flow increases, the liquid is "stretched" over the surface of the bowl with spraying along its entire perimeter. As the flow increases and a continuous layer of liquid forms on the surface of the bowl, the spraying shifts towards jet and film spraying. This is in good agreement with the literature [12].

Influence of wetting of the bowl surface. Despite the indication in [18; 19] of the need to wet the bowl surface with the melt, the model experiment failed to reveal any specific patterns in the behaviour of the liquid on the bowls under conditions of complete wetting and non-wetting. The experiment on the coated bowl showed contradictory data that require additional research. This may have resulted from the destruction and detachment of the applied barrier layer.

Changing the bowl geometry. As the results of process visualisation showed, the presence of sloped wall on the edge of the bowl is necessary to achieve a stable spraying process. This is in good agreement with the results of [10; 21]. Although the sources describe experiments on bowl slope angle of 60–70°, the use of bowl slope angle of 90° also proved to be effective. The experiment confirmed that the presence of sloped wall increases the distance that the liquid travels before spraying [10], but this, in our opinion, is not the main advantage of having sloped wall on the bowl. The main advantage is that the liquid droplets flying at an angle to the bowl surface as a result of premature spraying can be distributed along the sloped wall, and then sprayed in the form of small droplets through its edge. This can be of particular importance when the bowl surface is poorly wetted by the liquid.

Changing the liquid feed height. Changing the jet fall height within 20–150 mm has a significant effect on the occurrence of secondary spraying. There is an optimal height of liquid jet feed, which is in good agreement with the literature data [11]. In our experiment, the optimal range for stable spraying of the model liquid was 50–100 mm. A too high jet fall height leads to its premature destruction into smaller jets and droplets, which, if they do not hit the exact centre of the bowl, elastically bounce off causing secondary spraying of large particles. When the jet feed point approaches the bowl, it is more likely to hit its centre, which leads to stability of the spraying process. A too close location complicates the technological feasibility of implementing the liquid feed.

CONCLUSIONS

1. In general, the results obtained by the model liquid dispersion correlate with the literature data on the process, and allow evaluating the behaviour of the liquid on the bowl surface in terms of the formation of a uniform dispersion front without secondary spraying.

2. The start of the dispersion process at the moment of contact of the liquid jet should ensure that the jet accurately hits the centre of the rotating bowl; the liquid should be supplied from a height in the range of 50–100 mm. Otherwise, secondary spraying sources appear.

3. The main important parameter of the dispersion process is the creation of a liquid flow, that ensures uniform coating of the bowl surface with a liquid film and spraying from the entire periphery of the bowl. If the flow is insufficient, liquid ruptures and the formation of spirals and jets occur, which are dispersed on the bowl periphery.

4. On a smooth bowl, in contrast to a bowl without treatment, wettability is better and the film that forms on the surface is thinner. A rough bowl is the worst suited for spraying.

5. On a bowl with sloped wall, a decrease in the film thickness at the bowl edge is observed, spraying is more uniform. The sloped wall also break up the jets and drops of liquid into a film, which is then dispersed from the edges.

6. According to the literature, wetting should promote the movement of liquid within the boundary layer to the bowl periphery. On a model liquid under conditions of limited wetting, opposite results were obtained, which requires additional research.

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Исследование механизмов центробежного распыления на основе модельного эксперимента

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Поступила в редакцию 15.02.2024 *Пересмотрена 16.04.2024* *Принята к публикации 28.10.2024*

Аннотация: Процесс диспергирования расплава на вращающейся чаше является распространенным методом получения металлических порошков. Изучение процесса диспергирования на реальных расплавах, в том числе методами визуализации, затруднено. Поэтому влияние таких факторов, как высота падения струи, величина потока жидкости, смачивание поверхности, наличие стенки у чаши, на процесс получения мелких капель предложено изучить с помощью модельной жидкости без кристаллизации, фиксируя процесс путем высокоскоростной съемки. Цель работы – определение наиболее благоприятных условий диспергирования, когда вся подаваемая жидкость превращается в капли без образования крупных капель, дополнительных струй, приводящих к вторичному распылению. В качестве модельной жидкости выбран раствор глицерина в воде с вязкостью, равной вязкости расплава олова. Процесс диспергирования снимался на высокоскоростную камеру с частотой съемки 1200 кадров/с. Установлено, что при увеличении потока расплава наблюдается изменение режима распыления. При росте давления увеличивается поток и кинетическое взаимодействие струи с поверхностью чаши, а следовательно, избыток жидкости, который распыляется преждевременно. При любом потоке подаваемой жидкости, если жидкость не попадает в центр, происходит вторичное распыление за счет разрушения пленки на гидравлическом скачке из-за неравномерной радиальной скорости на пике скачка. При изменении высоты подачи от 100 до 150 мм наблюдается вторичное распыление в виде капель в месте гидравлического скачка. Количество спиралей и вторичное распыление влияют на увеличение размера фракции частиц. В диапазоне высоты падения струи от 50 до 100 мм отмечается оптимальный процесс, при котором можно получить наименьшую фракцию. В эксперименте наблюдалась тенденция к улучшению процесса распыления при повышении чистоты обработки поверхности чаши. За счет стенок чаши увеличивается путь жидкости до выхода ее с чаши, разрушаются в пленку капли, летящие над поверхностью чаши, вследствие чего улучшается процесс диспергирования.

Ключевые слова: центробежное распыление расплава; диспергирование расплава на вращающейся чаше; поток жидкости; металлический порошок; гидродинамические условия; высокоскоростная съемка.

Для цитирования: Жуков Е.Ю., Наурзалинов А.С., Пашков И.Н. Исследование механизмов центробежного распыления на основе модельного эксперимента // Frontier Materials & Technologies. 2024. № 4. С. 39–49. DOI: 10.18323/2782-4039-2024-4-70-4.