The change characteristics of the Mach number used in different spaces on the pressure of the local wing and the subsequent improvement of the aircraft wing

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Abstract. Fluid mechanics is not only applicable to aerospace, but also to our mechanical design, considering the comprehensive ability to make our manufacturing more reasonable and accurate, and keep us safe. In this paper, the fluidity of air fluid is analyzed and studied by programming method. By changing different parameters, different flow field distribution diagrams are finally obtained. The research results have reference value for practical engineering applications.

Keywords: fluid mechanics, aerospace, flow field.

1. Introduction

Since the birth of aircraft, designers have been trying various methods to improve its flight performance [1]. Traditional aircraft still can show good flight performance at a certain design state point. However, due to the more complex flight conditions of military reconnaissance and medical relief, the modern aircraft not only need higher flight speed [2], but also need a variety of long-range payload. In resent years, transonic flight plays a increasingly significant role in multiply area, military, scientific research, and even civil. As a result, the aircraft wing must be cautiously designed for transonic flight [3-4].

During the flight, due to the aerodynamic the wings are subjected to external loads to generate shear forces, bending moments and torques in the wing structure, forcing the wing to bend in the straight and parallel to the plane of the wing, and toward itself. Design aerodynamics is an important branch of modern aerodynamics. It mainly applies the latest achievements of computational and experimental hydrodynamics to the design and research of advanced aerodynamic layout and components. The purpose is to solve the geometry of the object according to the target pressure distribution carefully given by the designer [5].

That is why it is significant to research on the pressure on the wings to study the fluid flow above the wings and the influence of disturbance.

2. Method

In the fluid mechanics project learning, not only learned about the small disturbance fluid flow pattern and related motion changes, and about the early fluid need to have partial differential equation [6], but also learned in the case of correct use of Beta value and Minf value [7], below I will explain the subsonic and supersonic situation and production conditions and it must face objective interference conditions.

$$\frac{1}{h}[f(x+h)-f(x)] \approx f'(x)+O(h) \tag{1}$$

$$\frac{1}{2h}[f(x+h)-f(x-h)] \approx f'(x)+O(h^2) \tag{2}$$

$$\frac{\partial u}{\partial t}+a\frac{\partial u}{\partial x}=0 \tag{3}$$

$$\frac{\partial^2 u}{\partial t^2} + c^2 \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) = 0 \tag{4}$$

First, we need to clarify the meaning of this equation. The most important (1-M*M) phi_xx+phi_yy=0. The central differential method must be used in the use of phi_xx and phi_yy.

In this formula we must identify who is variable and invariant about x or y about phi. However, when using spyder or Pycharm to write code, we must pay attention to because subsonic is only a small disturbance in the air, so generally, Beta value and Minf value are very small, Beta value between 0 and 0.468 and Minf value is generally less than 0.7, so the fluctuation in the image is relatively small [8].

In my point of view, supersonic refers to faster speed above subsonic and sound. If we give different values to supersonic, it is not difficult to find that in different cases; for example, M=1.2, M=1.3, M=1.8, M=3.2 and M=4.3, we can easily understand the data of aircraft or fighter flight under different conditions [9].

But be sure to note that, most importantly, in supersonic cases because of the airflow parameters It is mainly affected by the upper airflow, so it is not necessary to consider the lower flow interference, because the speed is very fast, so we need to use another reverse flow equation.

Also for this equation, we must note that the values of phi_xx and phi_yy are changed to i-1 and i-2, and the effect of supersonic reception is complicated relative to subsonic.In general, Beta value and Minf value are very large compared with subsonic, Beta value between 0 to 0.678 and Minf value is generally greater than 1, for example, M=1.2,1.5,2.3,3.4 have more fluctuations than subsonic images, but we cannot assume too large M value, otherwise our image will not appear correct. Our purpose is to ensure that the image basically flows as expected within the minimum error range, so we control the range of M.

Transonic flight, also known as "Transonic flight".Refers to the flight of the whole supersonic airflow from a certain point on the surface of the aircraft in the supersonic flow field.In terms of flight speed, the upper limit Mach number of Transonic flight is roughly 1.2, and its lower limit varies according to the speed at which the aircraft produces a local shock wave.The Mach number is generally between 0.8-0.9.Transonic aircraft surface has both subsonic flow and supersonic flow; this hybrid flow field increases the drag, lift, instability, the actual flight process, "sound burst" phenomenon.So what is a sound explosion?What are the effects of the sonic explosion?Let me next tell you something about it."Sound burst" is a loud sound caused by a shock wave when the air moves through the speed of sound.Usually it is caused by supersonic fighters or other supersonic aircraft flying supersonic speeds.Such as the violent turbulence, so that the instrument error, the driver is difficult to operate, the body load increased, in the flight as far as possible to shorten or avoid Transonic flight.This is why supersonic flight is better than Transonic at the same standard atmospheric pressure; vehicles have to pass from subsonic to supersonic or from supersonic to subsonic zones [10-11]. When the speed exceeds the critical Mach number, the air flow around the vehicle is partially supersonic flow, and the air mechanics changes sharply, such as the appearance of shock waves; when the speed reaches Mach 1.2, all airflow is supersonic and the surrounding airflow becomes stable.

3. Results and discussion

In these code written by Python, different Beta values and Min-f values should be set according to the specific requirements of the speed of sound in different situations. Different system Settings will directly affect the display of fluid images, and then affect our judgment.In the above graphics, it is not difficult to find that in the subsonic speed, the Beta value must be set small to ensure its accuracy, generally between 0.00 and 0.50, and compared with the supersonic state, the Beta value is between 0.10 and 0.60, regardless of the interference of hypersonic factors, it is not difficult to find that with the increase of supersonic Mach velocity will increase. Figures 1 to 4 are the flow field distributions under different parameters.

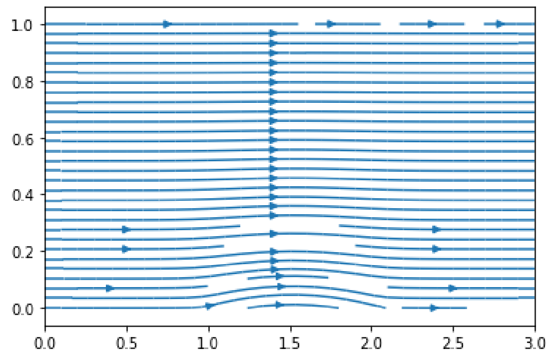

Figure 1. Subsonic: Beta=0.468, Minf=0.6.

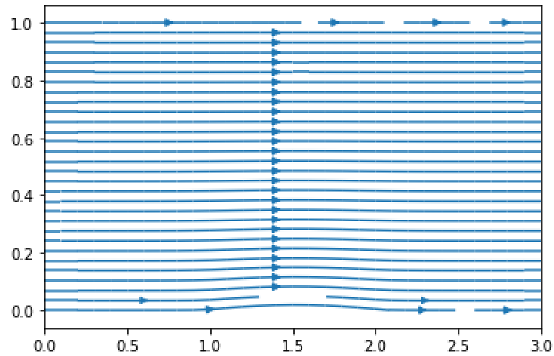

Figure 2. Subsonic: Beta=0.17586, Minf=0.5.

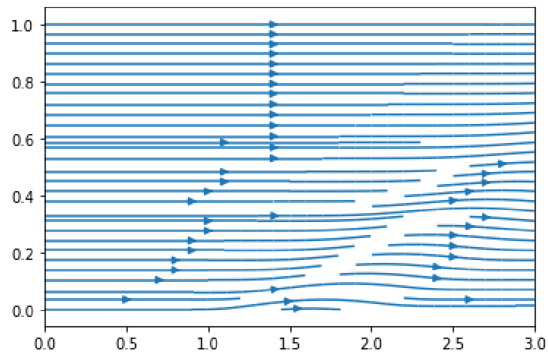

Figure 3. Supersonic: Beta=0.246, Minf=3.2.

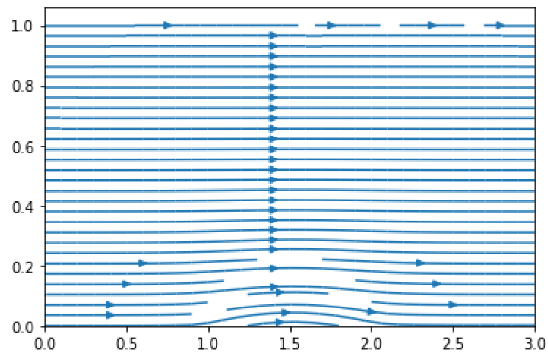

Figure 4. Supersonic: Beta=0.479, Minf=1.8.

Through this study, I realized that when studying fluid equations and problems, we not only need to consider the influence of airflow and air disturbance on fluid, but also need to consider the image of different M and Beta values, the error should be minimized to ensure that the expected requirements are met.

Fluid mechanics is not only applicable to aerospace, but also applicable to our mechanical design, considering the comprehensive ability to make our manufacturing more reasonable and accurate, to ensure our safety. Only consider the liquidity of the air fluid, do not consider the objective factors of oxygen scarcity in the atmosphere, under the subsonic, aircraft condition is relatively stable, and under the condition of supersonic, we have to consider the thermal effect in the air, this is not to say in the subsonic condition is no inside, just banana the latter can be very big, sonic explosion is a good example; Therefore, we need to ensure that the other factors of the flight trajectory and aerodynamic layout of the aircraft within a reasonable range to ensure the stability during flight. Therefore, it is crucial to choose more accurate Beta values and Min-f values. In the later study, we need to constantly improve the accuracy of its data to ensure the relative stability of the fluid.

4. Conclusions

Overall, on the basis of above result, this passage worked on solving problems through python programming. At the end of the program, we used the codes we developed to make a comparison of a nozzle flow, using the Euler equation and the small disturbance equation(SDE). This paper analyzes the case where the Mach number was greater than 1 and less than 1, and beta took different values. We use SOR relaxation as a method. It defined 4 functions to determine the values of A_xp, A_xm, B_yp, B_ym. In this way, we simulate potential models for subsonic, supersonic and transonic fluid flow above a bump (airfoil) or a nozzle. And analyze the influence when changing M_inf and beta.

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