How Do Drone Propellers Work? (Complete Beginner's Guide)

Drones are made up of an intricate system of components. There are several crucial parts. But there is only one which is also the most eye-catching — the propellers.

They work in tandem with each other and function as the drone's wings. This much may have been obvious. However, it's a bit more tricky to actually understand how they work. Here's the science behind it.

Drone propellers work by spinning from the force applied by the motor. The higher air pressure on the bottom of the propellers creates lift for the entire drone. Their rotation also keeps the drone stable and propels it to move forwards. These features are made possible by their unique design.

You might be wondering where the pressure difference actually comes from. In this post, I'll be answering that, and more, by using simple yet effective explanations.

As you grasp these concepts, you'll also be led to a greater understanding of drone flights in general.

What are drone propellers made of?

Before we work our way to the working of propellers, let's take a look at what materials are used to make them.

Drone propellers are generally made of two types of materials. Most drone models use propellers made of high-quality but soft plastic, such as nylon. On the other hand, high-end drone models, like the DJI Matrice 600, sport carbon fiber propellers.

But why is this important?

Here's the thing: the materials affect the stiffness of the propellers. In other words, their working is directly affected.

Plastic propellers are more flexible. This means the blades are more likely to stay in one piece after a crash. But they do tend to get noisy and aren't ideal for the drone's efficiency and balance.

Carbon fiber propellers solve these issues; they're quieter and offer better flight performances. However, you'll probably have to replace them in case of a severe crash.

How do drone blades spin?

Drone propellers need to start spinning before any lift is generated to facilitate flight. So, what gets them to spin?

Drone blades spin when force is applied on them. This force comes from the motors, which use the rotors to turn the propellers. The motors are powered by the drone's battery. As a general rule, the propellers spin faster when the motors generate more energy.

The motors spinning the blades in the correct direction creates a balance. I'll be touching more on this statement in a few of the following sections.

One crucial part of drone flight is the capacity of the motors. The drone will only fly if the motors can spin the propellers at a high enough speed.

How fast does a drone propeller spin?

The speed of spinning propellers can vary. We do, however, know that it's relatively high. Here are the specifics.

A drone propeller generally spins at the speed required to facilitate flight. According to researchers in Virginia Tech, most drone propellers spin at a rate of 8000 revolutions per minute (rpm). This translates to 133 times per second. The exact speed depends on the size of the drone.

It goes without saying that manufacturers of consumer drones consider the factors that affect propeller speed. Besides motor capacity, these factors also include the blade's diameter.

This allows them to construct the propellers in a way that they spin fast enough to generate the amount of lift needed.

You might be wondering: are propellers spinning at 8000 rpm dangerous?

Well, the short answer is yes. Spinning propellers are risky to touch as they can cut your skin, if not cause a severe injury.

What direction do drone propellers spin?

Earlier in the post, I mentioned how propellers need to spin in the correct direction but never specified what it was. Here's the answer.

Drone propellers always spin towards the drone's main body, regardless of the number of propellers it has. In the case of a quadcopter, both (front and rear) sets of propellers have a clockwise and a counterclockwise rotor. The idea is to make each set rotate in opposite directions.

Quadcopters, hexacopters, and octocopters all have *sets* of propellers. But how do things work in tricopters?

Generally speaking, the two propellers in the front spin in opposite directions while the one in the back has a counterclockwise rotation.

Why do drone propellers spin in different directions?

I've already hinted at the importance of propeller direction, but here's the actual explanation.

Drone propellers spin in different directions so the resultant torque acting on the drone is zero. This stops the main body from spinning. Each propeller in a pair creates torque as it spins but also rotates in the opposite direction to the other. Thus, the torque is counteracted and canceled out.

There are a few things to digest here.

You should familiarize yourself with torque. Simply put, torque is a measure of *rotational* force. And since it's a vector quantity, the direction of the force is also considered.

Another concept that comes into play here is Newton's third law of motion — the law of action and reaction.

When torque is generated by a spinning propeller, an equal and opposite force is also produced. This would cause the main body to spin along with the propellers.

However, we don't let that happen. The torque effect is canceled out as for every propeller rotating, there is also a propeller rotating in the opposite direction.

As a result, a balance is created and the drone actually becomes usable.

Which way do the blades go on a drone?

We know that the propellers need to spin in opposite directions. However, applying the concept in a practical situation may get slightly confusing. Here's what you need to keep in mind.

The blades go on a drone in accordance with its motors. A clockwise propeller goes on a clockwise motor, while a counterclockwise propeller goes on a counterclockwise motor. In case the blades have no labels, you can use their shape. A blade's protruding edge always spins towards the drone's body.

For the most part, however, your propellers will come with directions or markings to help you place them correctly.

Once you're done with the installation, you'll find the propellers rotating the same way to be at opposite ends.

The YouTube video below is a short, hands-on tutorial of this exact process. It will also clarify any doubts you may have about what the "protruding edge" looks like.

https://www.youtube.com/watch?v=V2vz0eGnmmI

How does a drone rotate?

Propellers are directly responsible for allowing you to fly your drone in different ways. And among the primary movements, one is the yaw rotation. Here's how it's done.

A drone rotates by increasing the speed of two propellers placed at opposite ends and rotating in the same direction. To rotate left, the propellers rotating counterclockwise move at a higher speed. To rotate right, the propellers rotating clockwise move at a higher speed.

Note that the above explanation applies to quadcopters, though other types of drones follow a very similar process.

The question is, why does increasing the speed of a set of propellers result in rotation?

For this, you'll have to recall the concept of torque.

We previously made sure there was no torque acting on the main body to keep the drone from spinning uncontrollably. Now, however, we deliberately allow the torque effect to take place — in a controlled manner.

When a set of propellers is rotating faster than the other, the torque in one direction also becomes stronger than the other. Therefore, an imbalance occurs and the drone's main body rotates.

This type of movement is generally controlled by using the left lever on remote controls.

Can drones fly sideways?

This is a pretty common question asked by novice pilots who're looking to make cinematic shots. But that's not all, sometimes a drone flies sideways without the pilot wanting it to.

Drones can, indeed, fly sideways. This is done by manually navigating using the roll control stick after positioning the camera to face the direction you want it to. However, if a drone is uncontrollably flying sideways, it's very likely the propellers are damaged or mounted incorrectly.

Should the latter take place, make sure the propellers are on the right way. There's a lot more to this subject though. If it's a problem you think you're facing, I suggest checking out my article on fixing drones flying sideways.

Don't get me wrong though, flying a drone sideways (when done deliberately) makes for *amazing* video footage. The YouTube video below shows a few shots you can try practicing.

https://www.youtube.com/watch?v=oyvee7KH6cQ

What would happen if we had all four motors rotating in one direction?

I've emphasized the importance of propellers spinning in different directions throughout this post. But it does beg the question of what happens if they don't.

I've already alluded to the answer, but here's the complete explanation.

If all four motors were rotating in one direction, a strong torque effect would be created in the same direction. Instead of just the propellers, the quadcopter would also continue

spinning on its own axis. The pilot would have no control over the drone's rotational movement.

Consequently, the imbalanced drone would ultimately be of little to no use.

Conclusion - how do drone propellers generate lift?

To wrap it all up, let's take a look at how the concepts of propeller rotation combine to generate lift.

Drone propellers generate lift by creating a difference in the pressure between the top and bottom surfaces of each propeller. Rotating blades push down on a mass of air and the reaction force, in turn, pushes up on the rotor. As the propellers spin faster, a greater magnitude of lift is generated.

Here's something to remember: generating lift doesn't guarantee flight on its own.

The total lift generated also needs to be greater than the force of gravity to counteract it.

Finally, you might be wondering why the lift generated doesn't cancel out similar to the torque.

While the propellers *are* moving in opposite directions, their blades have different angles. Different propeller blades allow the air to be pushed in the same direction so the vectorial sum of the lift generated is positive.

All in all, these concepts are only the tip of the iceberg for having a *thorough* understanding of drone flight.

I do, however, hope this post has formed a solid foundation using the basics of propeller workings.