Microphone: Technology Types and Features

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Abstract— Note on microphone features, different microphone technology types such as dynamic microphone, condenser, microphone, Ribbon microphone and carbon microphone. Comparison is done for how to buy the best microphone depending on the parameters such as Directivity/directionality, impedance, frequency response, response flatness the paper helps to make a choice based on the application and comparison made.

Keywords: Microphone

I. INTRODUCTION

Microphones are an essential part of any audio recording system. The microphone picks up the sound and converts it into electrical energy that can then be processed by electronic amplifiers and audio processing systems. Acoustic pressure can be measured using microphones. Microphones use the motion of circular diaphragms, induced by pressure changes fore and aft of the surface exposed to the measurement environment, to result in an electrical signal that corresponds to an amount of relative pressure change in the environment. Microphones come in all shapes and sizes. Also different types of microphone may use different technologies. These different types of microphone have different properties, and therefore a knowledge of the various forms of microphone will enable the best microphone type to be chosen for a given application. Microphones produce very small output signal levels. Accordingly they need to be connected to a preamplifier for the signal to be recorded or reproduced.

II. MICROPHONE FEATURES

There are many different parameters and issues to consider, When looking at the optimum microphone for any given application. Some of the features include the following features:

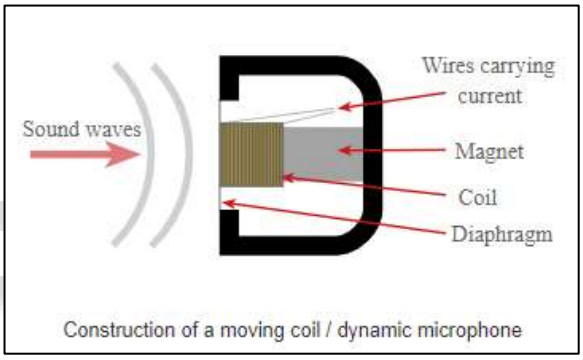
1) Type of microphone: There are different types of microphones available. Each type has its own characteristics and is best suited for particular applications
2) Directional characteristics: Microphones can have different sensitivity levels in different directions. The microphone directional characteristics are important in making sure the microphone used can pick up all the sounds that are needed. Microphones are often characterized by directional capabilities which are of great importance. Decide which type of directional pattern best fits your needs. Remember that it's usually better to use a less directional mic in a position close to the sound source, than to be further away using a hyper cardioid.
3) Diaphragm size*:* Microphones with different diaphragm sizes have different characteristics and are therefore often used in different applications.
4) Frequency Response: Make sure the mic's frequency response is appropriate for the intended use. As a rule of thumb flat response patterns are best, but in many cases a tailored response will be even better
5) Impedance: The rule of thumb is: Low impedance is better than high impedance.

III. MICROPHONE TECHNOLOGY TYPES

A. Moving Coil / Dynamic Microphone

For stage performances and many other applications this type of microphone is widely used. The moving coil microphone, has a small cone with a coil wound at its apex. This is held in a magnetic field and a current is induced in the coil as it moves in line with the sound vibrations.

An electric current is induced in dynamic or moving coil microphone if a wire held within a magnetic field is moved.



Construction of a moving coil / dynamic microphone

The dynamic microphone consists of a magnet, and a diaphragm to which a coil is attached. The assembly is held in place by an outer casing and the coil can move freely over the magnet. As sound waves hit the diaphragm, this causes the coil to move backwards and forwards within the magnetic field and as a result an electric current is induced in line with the incoming sound vibrations.

1) Dynamic Microphone Features

The dynamic microphone is very sturdy and can tolerate comparatively rough handling. This type of microphone is useful for certain musical instruments because they are able to handle high sound levels without distorting. They do not require an internal preamplifier like some types including the condenser microphone

Whilst the response of the dynamic microphone is not bad, they often have a response peak around 2.5kHz or so. Advantage of response peak is that it can increase the intelligibility of speech under some circnumstances, although it can make lisps or other similar affects worse.

This is sometimes described in the marketing literature as a *presence effect*. It emphasises the ambient noise which tends to be around this frequency. It also gives what is often termed a bright tone to the audio and this is often liked in some situations where it enhances a musical instrument or lifts the vocals.

The peak is well damped in more expensive dynamic microphones, although in less expensive models the peak can be quite significant.

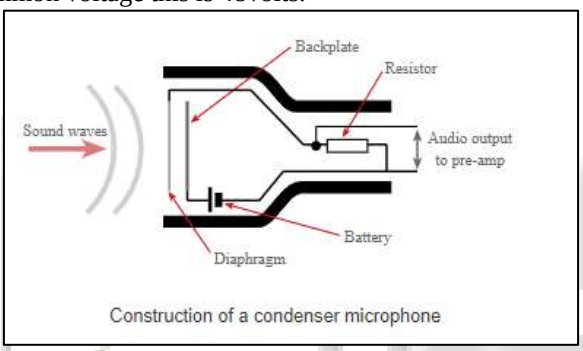
Although the inertia caused by the coil can limit the top frequencies that can be handled, The overall frequency response of these microphones is good.

B. Condenser microphone

As the name implies the condenser or capacitor microphone relies on changes in capacitance for its operation.

The actual condenser microphone element consists of a thin membrane acts as the diaphragm and is electrically conductive, in close proximity to a solid metal plate. Older microphones used a thin metal foil but more modern types may use a plastic coated with gold or aluminium. One common type is gold-sputtered mylar.

This construction creates a capacitor which may be in the region of 10 to 50pF. it requires a DC voltage to be applied for the condenser microphone to operate. This can be supplied by the battery shown, but for high end microphones it may also be supplied along the coaxial line to the microphone – this is known as phantom power. The most common voltage this is 48volts.



Construction of a condenser microphone

This voltage not only provides the voltage needed for the microphone to operate electrically but also pulls the diaphragm taut. When sound waves hit the microphone, the diaphragm moves backwards and forwards. The level of capacitance is changed and as a result small voltage changes are seen across a high load resistor connected across the microphone element. As the impedance of the condenser microphone is very high a buffer amplifier is needed which has the effect of converting the signal so that it has a much lower impedance. This amplifier is also powered either from the internal battery or from the phantom power line.

1) Condenser microphone features

The microphone has a flat and extended frequency response because of very low mass inertia of the diaphragm. In fact condenser microphones offer the widest frequency response, an best transient response of any microphone allowing them to faithfully pick up the attack of a drum or the "pick" of an acoustic guitar. condenser microphones usually offer much higher sensitivity and lower noise than dynamic microphones.

The basic microphone element requires a low noise preamplifier to ensure that microphone element is not loaded. The power for the capacitor and preamplifier is normally provided as phantom power from the mixer, or from a small battery within the microphone.

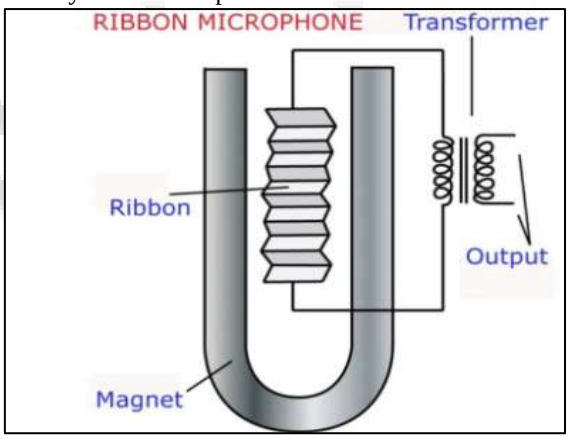
As a result of the high sensitivity, care needs to be taken in selecting them for applications where they will not be overloaded as these microphones can be overloaded by very loud sounds. As its internal construction is relatively delicate ,the condenser microphone is not as robust as the dynamic microphone.Whilst this results in a low inertia system that gives a good response, it also means it is less robust.

The other main issue is to avoid humid environments be aware of when using a condenser microphone. High levels of humidity have been known to cause internal flashover between the diaphragm and the back plate of the microphone element.

C. Ribbon Microphone

The ribbon microphone consists of a corrugated aluminium ribbon suspended edgewise between the poles of a magnet. The ribbon microphone is designed so that there are only very small gaps between the edges of the ribbon and the magnet sides. This means that the ribbon is moved by the velocity of the air rather then the sound pressure acting upon it.As a result of this feature the ribbon microphone is known as a velocity microphone.

As the ribbon microphone has a single conductor passing through the magnetic, the ribbon microphone has a low output impedance. To overcome this these microphones normally have an internal step up output transformer. Modern ribbon microphones use high performance magnets and efficient transformers and their output can sometimes exceed that of a dynamic microphone.



Ribbon microphone features

There are several aspects to the ribbon microphone – it offers a variety of features.

1) Fidelity: The electrical version of the sound quality is very high when using a ribbon microphone. The mass of the ribbon is very low in view of the fact that it is particularly thin. This means that it has a low inertia and it has a good high frequency response.
2) Resonance: The resonance frequency of the microphone is high – well above the audible region and therefore it does not colour the response. This results in a good flat response, and it sounds less bright than a moving coil microphone and as a result it produces a more pleasing sound.
3) Directional pattern: The most common directional pattern for ribbon microphones is a bidirectional figure of eight pattern. In addition to the standard bidirectional pick-up pattern, ribbon microphones can also be configured to have cardioid, hypercardioid,

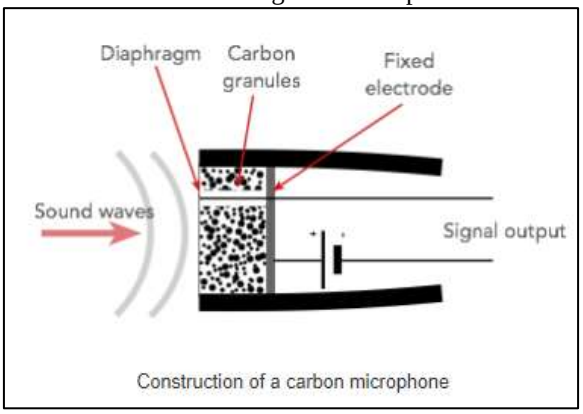
omnidirectional, and variable polar patterns, although these configurations are much less common.

4) Use with public address systems: The flat response means that public address systems can be used with a higher gain that with other types of microphone like the dynamic one that has a lift around 2.5 to 5 kHz. A lift of this nature advances the onset of acoustic feedback in this range, thereby reducing the overall gain that can be used. That said, some microphones deliberately have a peak introduced to give them a higher 'presence.' Check the frequency response before buying and using.
5) Positioning: if the microphone is too close to the speaker then the plosive sounds including 'p', 'b' and others produce a particularly bad pop. Also the bass is unnaturally enhanced.
6) Sensitivity: The ribbon microphone does not have multiple wires cutting the magnetic lines of force – it is only the single ribbon and not the multiple turns of wire as in a moving coil or dynamic microphone. This means that the sensitivity is much less than that of a dynamic microphone.
7) Robustness and durability: early ribbon microphones could be damaged by shock and even blowing into the microphone. Modern ribbon microphones can be used for a variety of applications including loud rock music and are much more robust

D. Carbon Microphone

The basic concept behind the carbon microphone is the fact that when carbon granules are compressed their resistance decreases. This occurs because the granules come into better contact with each other when they are pushed together by the higher pressure.

The carbon microphone comprises carbon granules that are contained within a small contained that is covered with a thin metal diaphragm. A battery is also required to cause a current to flow through the microphone.



Construction of a carbon microphone

When sound waves strike the carbon microphone diaphragm it vibrates, exerting a varying pressure onto the carbon. These varying pressure levels are translated into varying levels of resistance, which in turn vary the current passing through the microphone.

The varying current can be passed through a transformer or a capacitor to enable it to be used within a telephone, or by some form of amplifier.

The frequency response of the carbon microphone, however, is limited to a narrow range, and the device produces significant electrical noise. Often the microphone would produce a form of crackling noise which could be eliminated by shaking it or giving it a small sharp knock. This would shake the carbon granules and enable them to produce a more steady current.

1) Features of Carbon Microphone

As radio started to be used, the carbon microphone was initially used there as well – for broadcasting as well as communications purposes. However their use in broadcast applications soon came to end because of the drawbacks of noise and poor frequency response. Other types of microphone started to become available and their use was preferred because of the better fidelity that was available. The use of the carbon microphone persisted for many years for communications purposes as they gave a high output and they were robust. The poor frequency response was not an issue.

The carbon microphone was used for telephones up until the 1970s and 1980s, but even there it became possible to use other types of microphone more conveniently. Also the crackle and noise of the carbon microphone had always been an issue and when other types of microphone became available at a low cost they started t be used, despite the requirement for additional electronics needed.

Carbon microphones are now only used in a very few applications – typically only specialist applications. They are able to withstand high voltage spikes and this property lends itself to use in a small number of applications.

E. How to buy the best microphone

Microphones is expensive so it is necessary to look at what is needed to buy the best microphone.

Microphones are used in many places and for many jobs. There is also a huge selection of microphones available, so it is necessary to buy the right microphone for the job in hand. Knowing what is required and how to buy the best microphone is not always easy. There are different requirements for different applications. However by looking carefully at what is needed and then matching the characteristics of the different types of microphone, it is possible to know how to buy the best microphone for any given task.

1) Analyze what is needed

The first step when buying any microphone is to analyze exactly what is needed. Different applications have very different requirements, and different types of microphone have very different characteristics.

By matching what is needed to the characteristics of the type of microphone, the basic type can be chosen. Then it is a matter of looking at the individual specifications and buying the microphone that suits the application best.

2) Microphone types

When buying microphone it is useful to summarize the different types of microphone to see what is available.

MAJOR TYPES OF MICROPHONE

MICROPHONE TYPE	FEATURES
Moving coil / dynamic microphone	Widely used for stage vocals, PA use, etc. This microphone is very sturdy and can tolerate comparatively rough handling. Dynamic microphones are also able to handle high sound levels without distorting.

	They typically have a low output impedance and a relatively high output level and they do not need an internal pre-amplifier and hence there is no requirement for phantom power.
Condenser/ capacitor microphone	Condenser microphone is often used for high quality audio, both vocals and also instrumentals. It does not tolerate being overloaded well, and it requires power, both to add a bias to the capacitor and also for the preamplifier needed. They are not as robust as dynamic microphones. The output impedance is generally low to enable longer leads to be used. When used for vocals or general voice it may be worth considering an additional pop filter to reduce pops from plosive sounds
Ribbon microphone	The ribbon microphone used to be the top end microphone for studio work. Now it is not as widely seen, except for high end microphones. The output is low and needs a preamplifier, and it has a very low impedance - normally as a result the microphone uses an internal step up transformer. Costs to uy are normally high.
Electrets microphone	The Electret microphone tends to be sued for lower end microphone applications. It uses the same basic technique as the condenser microphone except that the dielectric is made from a material that holds a bias voltage and therefore it does not require external power for the microphone element itself.
Crystal microphone	Crystal microphones or ceramic microphones are generally low cost units offering a high output voltage into a high impedance - hence the amplifier must have a high input impedance. The microphones tend to be at the bottom end of the market as they do not offer a particular wide frequency response and in view of the high impedance they are not widely used these days. The high impedance level means that the microphone cables are prone to noise and general stray pickup.

3) Other specifications to consider

There are other specifications to consider when buying a microphone. Even though the choice of microphone type may be straightforward, there are other aspects to consider on top of this when considering the best microphone to buy.

Directivity/ directionality	The directivity or directionality of the microphone is an important factor to consider when buying a microphone. Most microphones used for vocals and PA applications have a cardioid directional pattern.
Impedance	Most microphones are low impedance and designed to operate into a low impedance load. it is necessary to ensure that the impedance is the right value when buying a microphone. However some microphones, e.g. crystal or ceramic microphones have a high impedance and the amplifier or other amplifier into which it is connected must have a suitably high input impedance, often around 1 MΩ.
Frequency response	It is necessary to ensure that the frequency response is sufficient for the applications. For some instruments like strings that may extend well down in frequency whilst also requiring a good high frequency response, the overall response may need to be very wide, necessitating a more expensive microphone. Vocals tend to require a good but not excessive frequency response.
Response flatness	Whilst it may appear that a flat response is ideal, sometimes a treble lift can be used to advantage, especially for vocals. However be aware that for PA applications, this can make the system more susceptible to howl round, where the signal from the speakers gets into the microphone and sets up a howling noise. Dynamic microphones often have some treble lift and this lends itself well to many vocals.

4) Cost

Cost is a major issue for anyone buying a microphone. In general the higher the cost, the better the microphone, but not always so.

However in general the manufacturers of higher end microphones like Sennheisser, AKG, R0DE and the like have many excellent microphones to offer. For more budget orientated purchases other makes are available and can offer some excellent value.

The choice of microphone to buy is dependent upon very many factors: technical, cost; aesthetics; usage and many other factors. When buying a microphone it is necessary to ensure that it meets the current requirements, and possibly some into the future. Investing in a good microphone will normally be money well spent. Sometimes economising may expedient in the short term, but not be satisfactory in the long term.

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