Aurora ELECTRONICS LTD. TECH SHEET

Understanding Spark Plug Wires

While spark plug wires may seem to be simple components, there is a reasonable amount of technology that goes into their design. This article will help consumers make informed choices while dispelling some common misconceptions.

The basic function of a spark plug wire is to conduct spark energy from the ignition source, whether it be a distributor or coil pack, to the spark plugs. The more efficient the wire the more spark energy is transferred to the spark plug.

In The Beginning

Probably the most efficient transfer of spark energy is made with solid core spark plug wire. This type of wire was extensively used prior to the 60's before the introduction of car radios as standard equipment. A few modern day exceptions exist such as certain race applications and a few European car manufacturers. The problem with solid core wire is that it emits large amounts of RFI (radio frequency interference) which affects radios, and onboard electronic systems in cars. When current passes through a wire, a magnetic field is formed. If the current flow is switched on and off rapidly as with an ignition system, RFI is caused by the magnetic field collapse (some refer to it as EMF which stands for electromotive force). When manufacturers started installing radios in cars, a solution was needed to reduce the RFI. One of the first solutions was to mount resistors on the wire ends to reduce the current flow and consequently reduce the EMF and resultant RFI. The second solution, and the most popular by far, was to make the whole wire a resistor. Thus the age of carbon core wire (sometimes referred to as graphite core) was born. This type of wire needed a whole new type of construction over conventional solid core wire. Carbon core wire's basic construction starts with a non conductive structural member (nylon or Kevlar™) over which carbon fibers are deposited. These carbon fibers are typically blended with latex or silicone to form a flexible coating. A layer of EPDM rubber is then deposited over the core as primary insulation. Next a nylon bonding weave is placed over the wire which is followed by a final coating of either EPDM or silicone rubber.

When new, this wire performs as designed. Over time however, with heat and vibration the carbon fibers tend to loosen which degrades conduction and eventually requires replacement. For this reason some OEMs (original equipment manufacturers) recommend replacement every 3 years or 60,000 KM. Carbon core wire is quite economical for manufacturers to use while suppressing sufficient RFI. This wire typically has a resistance of 3,000 to 20,000 ohms /ft. depending on the manufacturer.

O.K. So Where Do We Go Now ?

Previously mentioned, RFI is reduced by limiting the current flow in the wire. This reduction of current flow also results in a weaker spark to the plugs. An internal combustion engine operates on the principal of air and fuel burning in a cylinder and the expanding gases driving down the piston. That's right the fuel burns, not explodes as some believe. The hotter the spark in the cylinder the better the air/fuel ignition and better chance at complete combustion. We will come back to this in more detail later on, along with some common misconceptions. Since the hotter the spark the better combustion, an engine's efficiency improves, simple fact. Carbon core wire is not our most efficient choice here, and solid core wire can't be used on modern vehicles. So where do we go from here ? The newest technology is wire wound construction which can go under many names such as magnetic suppression wire (mag wire), spiral core, helical core and so on. Although this type of wire is more costly than carbon core, vehicle manufacturers are using this type of wire more and more in newer vehicles for better efficiency and longer life.

So what is this "mag wire" wire all about ?

Let's begin with the basic construction of the wire, then get into some details that set brands apart from a performance and quality point of view. Mag wire begins with a non-conductive structural member such as nylon or Kevlar™ (just like carbon core wire). Over this member is wound a fine alloy wire in a spiral or helical fashion. The closer the turns are wound, the better the wire's quality and higher the production cost. Over this winding is deposited a choice of coatings, the lowest cost is again carbon in latex while the best and most expensive is ferrite (iron particles) suspended in a latex or silicone type coating. Covering this finished center conductor is either extruded EPDM or silicone rubber (much the same as carbon core wire).This wire's core performs a number of functions. First the spiral wound conductor conducts the spark energy efficiently and second it acts as a "choke" against the RFI. Thirdly it adds greater physical strength to the wire.

The tighter the windings, the better the choke performs. The diameter of the center conductor is also of paramount importance, as the greater it's diameter becomes, again the better the choke's performance. The use of carbon latex coating further absorbs some RFI, however ferrite is vastly superior in noise suppression, however more expensive as previously mentioned.

There are many differing constructions of mag wire, some economical brands simply wind a fine wire around an existing carbon core wire center. Another economical method is to loose wind the conductor over a small center diameter to cut production costs. Almost anything goes just to call it mag wire.

To design a true mag wire and have it suppress RFI while transferring virtually unimpeded spark energy is no small task. Some manufacturers advertise very low resistances, which when conducting D.C. current (direct current) is good. However ignition systems also generate A.C. (alternating current) voltages which traverse the outer layer of the conductor and is less affected by resistance. For a mag wire to suppress RFI properly it needs a certain amount of resistance. Along with the afore mentioned spiral wound design and ferrite coating, we get a wire that now has inductive reactance which suppresses RFI. Inductance is a function of the spiral winding and is further enhanced by the ferrite which effectively multiplies it. Without further complexity, the whole idea is to get a balance between conduction and RFI suppression.

Misconceptions

As touched on before, the hotter the spark the better the combustion. This process can be associated with a better transfer of the spark energy from it's source. Misconception #1 " Any spark is adequate for combustion since it only needs to explode the fuel " - not true. Fuel is meant to burn in a cylinder, not explode (fuel only explodes under such cases as pinging or detonation both of which are quite harmful to an engine). A weak spark may start the combustion process but since there is a finite amount of time for the mixture to burn prior to the exhaust valve opening, a better start of the combustion process will aid in a more complete burn. Misconception #2 " Hey, I heard too hot a spark burns holes in pistons ? " - NO ! . Improper fuel mixture and/or incorrect ignition timing can cause this, not a strong spark. By assuring a good spark reaches the cylinder, a proper burn of the fuel mixture can take place. Better energy transfer will also increase spark duration which is a function of current flow. The longer the spark is present, the larger the portion of the swirling mixture is ignited which allows more complete combustion. This inevitably gives you the most from the fuel entering the engine.

Misconception #3 " If mag wire is so good wouldn't it come as standard factory equipment ? " Manufacturers have to balance performance and features against production costs. Most replaceable parts on a car can be found in a better quality or higher performance aftermarket version. Spark plug wires are no exception.

Aurora's Design

Now a little about Aurora's design. As mentioned before, the A.C. component of the spark energy travels over the exterior of the conductor. This is why Aurora uses an alloy conductor with a relatively large cross section (commonly twice the cross section of most). Next the conductor is closely wind over a 0.08" diameter core which gives a rather large winding diameter in relation to finished wire size. The winding is then packed with large amounts of ferrite to increase RFI suppression. The conductor is a stainless steel alloy which gives exceptional strength and a planned resistance of 400 ohms/ft. The winding is so close that 22 inches of this conductor is found in every inch of finished ignition wire! Aurora's insulation choice is a first layer of EPDM, which has a higher dielectric strength than silicone, followed by a nylon tape layer. This nylon tape bonds a silicone outer jacket, chosen for heat resistance and flexibility, to the inner EPDM layer. This tape layer also provides superior bonding as compared to the earlier nylon weave which is still in use by most manufacturers.

Low Resistance

If you are shopping around for spark plug wires, you have probably been bombarded with two heavily advertised features. The first is low resistance. Most would agree that the lower the better right? However be very careful, as too low means that the inductive reactance will also be low and not provide sufficient RFI suppression. One must also remember that conductor cross section is important to the transfer of the A.C. component of the spark energy. Since these alloys have engineered resistance, one cannot ascertain what the diameter really is from a ohms/ft value. Very low resistance wires commonly use copper alloys which are not as structurally strong as stainless steel. Lower in this case is not necessarily better!

Size

The second most advertised feature is size. Just because the wire has a large finished diameter doesn't tell you what is inside. Some manufacturers offer 10 or 11 mm wires, but these have usually proven to be a basic 7mm wire with extra insulation. Aside from robust appearance, it doesn't perform any better than the cheaper 7 mm wire. Often carbon core wire is also sold in large diameter configurations.

Aside from it's larger size, don't expect it to work any better that a basic set at half the cost. Aurora has chosen a size of 8.5mm which offers optimal insulation against voltage leakage and heat resistance.

Shop Informed

At Aurora many years of research and development have produced what we consider to be the very finest ignition wire sets you can buy. Our choice was to build a premium quality and performance product using only the finest components. Virtually all applications are covered from foreign and domestic cars, light through heavy duty trucks, marine, forklifts, and Harley Davidson motorcycles. Aurora also engages in custom industrial applications. This article was intended to give a basic understanding of different wire constructions and their effect on vehicle performance.

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