

NON GRAIN ORIENTED ELECTRICAL STEEL (NGOES)

Arnold's Non Grain Oriented Electrical Steel (NGOES) is manufactured in thicknesses of 0.005" and 0.007" (0.127 mm and 0.178 mm) under the trade names Arnon 5 and Arnon 7. Arnon 5 and 7 are available in the following dimensions:

	Slit Width Minimum	Slit Width Maximum
Arnon 5 0.005" (0.127mm)	0.20" (5.08mm)	17.0" (431.8mm) as rolled 16.5" (419.1mm) with a slit edge
Arnon 7 0.007" (0.178mm)	0.20" (5.08mm)	17.5" (444.5mm) as rolled 17.0" (431.8mm) with a slit edge

These materials are produced using our proprietary process that begins by rolling a heavier gauge 3% silicon steel Grain Oriented Electrical Steel (GOES) to the required thickness and then "unorienting" it. This unique process creates a thin gauge steel with superior properties for use in Industrial, Aerospace, Defense, Semiconductor, and Medical applications.

Arnon NGOES material meets IEC 60404-8-8.

SMALLER, LIGHTER, MORE EFFICIENT MOTORS AND GENERATORS

Arnon silicon steel is frequently used as laminations in high speed, high efficiency motors and generators. Whereas common laminations use 0.014" to 0.032" (0.356 mm to 0.813 mm) thicknesses, Arnon 5 and Arnon 7 are thinner at 0.005" and 0.007" (0.127 mm and 0.178 mm) respectively. The laminations are located in either the rotor or the stator depending on whether the laminated structure is used in a rotating or stationary design. The laminations are generally made from NGOES since they are circular and the magnetic properties are equal in all directions.

Arnon is best for higher frequency motors and generators above 400 Hz where using the thinner material offsets the less efficient effects of increased eddy currents and subsequent heat buildup. Using thin laminations of Arnon produces a more efficient unit and frees up design constraints by allowing for fully enclosing the motor without external cooling, for example.

Arnon is proven to lower core loss by as much as 50% compared to other NGOES materials. Some motors using Arnon have been tested to exceed 97% efficiency.

WHY ARNON?

Thin gauge Arnon silicon steel provides efficiency improvements at higher frequencies above 400 Hz with exponential efficiency gains as the frequency increases.

- Arnon is usable at higher frequencies than cobalt-iron (Hiperco 50) materials. Co-Fe materials are not recommended for applications over 1200 Hz whereas Arnon Si-Fe is the preferred material to at least 10 KHz.
- Low coercivity coupled with the hysteresis curve shape of Arnon provides reduced hysteresis loss in rotating machinery, yielding a more efficient motor or generator with less heat buildup and better performance (e.g. improved torque density) and/or the ability to maintain constant RPM'S under load.
- Arnon exhibits up to 50% lower core loss than competitive non-oriented silicon steel when driven by the same field, confirming Arnon's lower coercivity and improved hysteresis curve shape.
- Low loss Arnon is especially useful in totally enclosed motor designs where heat cannot be easily removed.
- Arnon is significantly less expensive than Co-Fe (Hiperco 50) – about 1/3 its cost.

IMPROVING MOTOR EFFICIENCIES WITH ARNON™

Motors, Generators and many other types of electrical machinery use permanent and soft magnetic materials. There are many options for soft magnetic materials just as there are many different permanent magnet materials. The most common soft material is silicon-iron (Si-Fe). When this material is manufactured, it becomes oriented which is beneficial for some applications such as transformers. However, rotating machinery benefits from non-oriented Si-Fe such as our Arnon brand material.

The thin layers of soft magnetic material are referred to as laminations. Common lamination thickness (gauge) is 0.014 to 0.032" in thickness. At higher frequencies such as found in modern motors and generators, the thinner materials perform better. Arnold makes two grades of non-oriented: Arnon 5 (0.005") and Arnon 7 (0.007").

There are only a few competitive sources of Si-Fe in these thin gauges and Arnold is the only domestic producer. Arnold uses a high grade oriented 3% Silicon steel which is purchased and rolled to gauge. Proprietary processing is used to produce a non-oriented product that exhibits properties superior to competitive materials.

BENEFITS

The particular benefits of Arnon (relative to the competition) are as follows.

- 1) Thin gauge Arnon provides efficiency improvements particularly at higher frequencies. Below 400 Hz the loss differential is minimal. But as the frequency increases, the loss differential becomes exponentially greater.
- 2) Arnon is usable at higher frequencies than cobalt-iron (Hiperco 50) materials. The Co-Fe materials are not recommended for over 1200 Hz whereas Si-Fe is the preferred material to at least 10 KHz.
- 3) Arnon is significantly less expensive than Co-Fe (Hiperco 50) (about 1/3 of the cost of Hiperco 50). Hiperco 50 is the Carpenter trade name for a 50% cobalt material similar to Vanadium Permendur. It is used for motor laminations and for transformer cores where improvements in magnetic properties outweigh higher core loss.
- 4) Low coercivity coupled with the hysteresis curve shape of Arnon provide reduced hysteresis loss in rotating machinery. This means a motor or generator will run more efficiently and with less heat build up and that leads to better performance (e.g. improved torque density) and/or the ability to maintain constant RPM'S under load. Core loss is energy lost to heat.
- 5) Arnon exhibits up to 50% lower core loss than competitive non-oriented silicon steel when driven by the same field.
- 6) Low loss Arnon is especially useful in totally enclosed motor designs where heat cannot be easily removed.