ELECTROMAGNETIC FIELD AND LOSSES

There is a big difference between a resistance in a DC and in a AC circuit under voltage. Motors, lighting installations, cables, electrical supply panels, transformers, switches etc. underlie to external effects (for example inductive voltages from neighbouring cables). Such effects may lead to increase of impedance, thus power losses increase from 10% to 25% of the power demand in a typical industrial installation. The precise calculation of various losses that contribute to the total losses is a complicated problem that can be solved trough a theoretical model deigned by SEMAN's scientists.

The following analysis features a summary of the main factors that contribute to losses in the electrical installation of an industry. In this point we should mention that losses are depended on the current and thus can be reduced by reducing additional currents that run in the electrical installation.

A. Joule Losses

Because of the fact that cables have ohmic resistance when current pass trhough cables, thermal losses are produced which are proportional to the square of that current. These ohmic losses are produced by the "crash" of electrons on the metal grid of ions

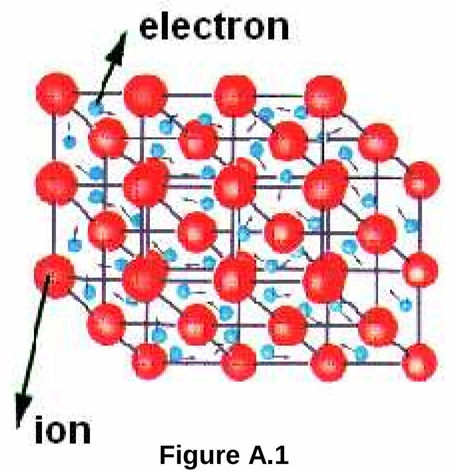

Figure A.1

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which forms the current conductor (Figure A.1). Moreover, additional thermal losses are produced in the connection points of cables with switches, fuses, motors and so on. These losses increase especially when the connection points are wearing enough.

Typical losses in supply cables of an electrical installation as a percentage of the total power demand may vary from: ***1% to 3%.***

B. Skin Effect Losses

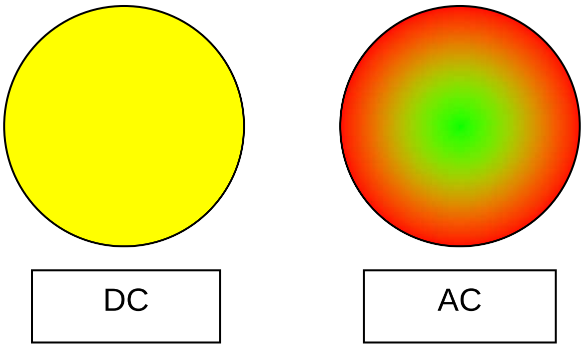

Figure B.1

The real resistance of a conductor is higher in the AC than in the DC current. The alternating magnetic flux that is created by AC current that pass through a conductor, interacts with the conductor itself and produce a reverse electromagnetic field, which resists in the passage of current. Thus, current can't exploit all the beneficial cross-section of the conductor for his passage, but only a small part in the exterior surface. This phenomenon is known as skin effect. This un-uniform distribution of current increase the real resistance of the conductor and the losses accordingly (Figure B.1).

Typical losses due to skin effect of an electrical installation as a percentage of the total power demand may vary from: ***2% to 8%.***

C. Contiguity Effect Losses

When cables that supply various loads are in near from each other distances, specifically in the case that cables are mounted in racks, currents produce electromagnetic fields that interact with each other. These electromagnetic fields create an un-uniform distribution of density of current in the section of conductor. This leads to an important increase of resistance in the cable (Picture C.1).

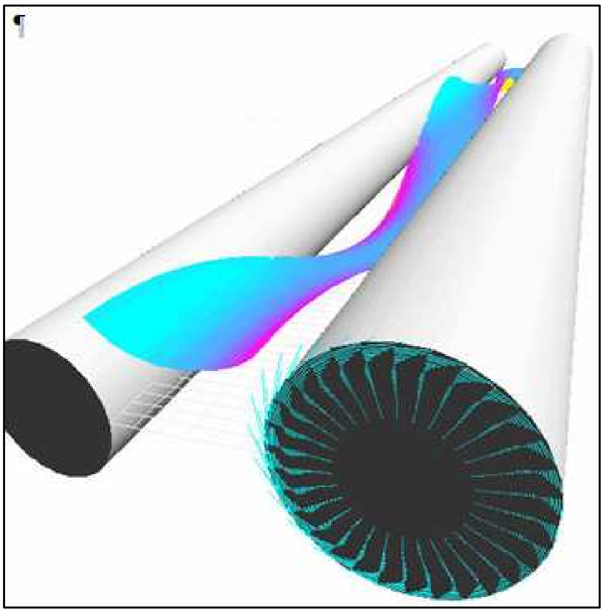

Figure C.1

Typical losses due to contiguity effect of an electrical installation as a percentage of the total power demand may vary from: ***4% to 10%.***

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D. Eddy Current Losses

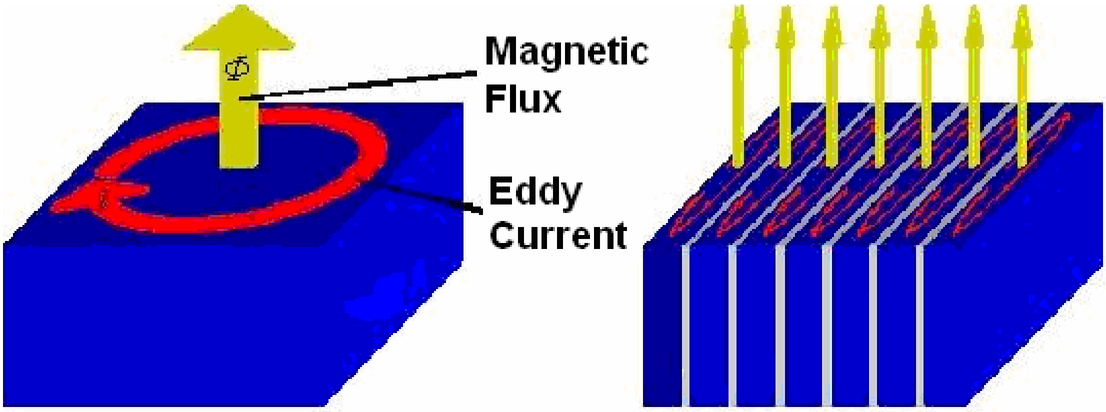

Figure D.1

The eddy current losses are presented in power switches, in ballast of lightings, in transformers, in power relays, in isolation transformers, in over-current relays, even in supply cables especially when these neighbor with steel or iron installations as distribution cabinets and cable racks (Figure D.1). These losses are owed to the production of circular currents in conductive stuff that is under the effect of alternating magnetic fields.

Typical losses due to eddy current effect of an electrical installation as a percentage of the total power demand may vary from: ***1,5% to 4%.***

E. Magnetic Hysteresis Losses

Hysteresis losses are heat losses that are caused because of the magnetic capacity of the ferromagnetic circuit (e.g. AC motor) (Figure E.1). During the operation of the motor the ferromagnetic circuit is submitted in a magnetic field and his magnetic dipoles tends to be aligned with the magnetic lines of field. Because the magnetic field is alternating, the continuous movement of magnetic dipoles, while they try to be aligned with the magnetic field, produces molecular friction. This friction produces heat and then energy losses. These losses tend to be increased when the motor is underloaded.

Hysteresis losses are presented as well in power switches and relays, in ballast of lightings, in transformers etc.

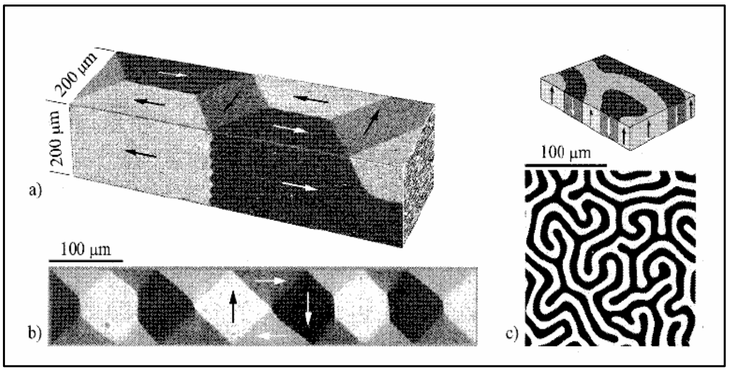

Figure E.1

Typical hysteresis losses as a percentage of the total power demand may vary from: ***1% to 2%.***

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