TECHNICAL DATA SHEET VENTILATION

On machines (either commutator or slip ring) most of the brush heat losses are dissipated by convection and, generally, it is the air which serves as a cooling agent.

01 – AIR FLOW

The air flow should be proportional to the losses to be dissipated and to calculate this air flow one generally uses the formula:

$$Q_v = \frac{P_t}{0.279 \times \rho \times \Delta T}$$

Where:
Q_v is the air flow, in m^3/h
P_t is the total loss to be dissipated, in watts (for brush losses see TDS-05)
ρ is the air density, in kg/m^3, which is a function of temperature and altitude (or pressure)
ΔT is the difference in the air temperature between the inlet and outlet of the machine, in °C

REMARK

For the determination of air density, formulae may be found easily on the internet.
The value at 20°C at sea level (0 to 100m of altitude) is $1.204 kg/m^3$. Therefore the formula above may be simplified:

$$Q_v = \frac{P_t}{0.34 \times \Delta T}$$

Actually, a ventilation system is considered as being efficient when the temperature difference ΔT between the inlet and the outlet of the air is between 10 and 25 °C.

The necessary air flow can also be estimated according to the machine power since the losses are roughly proportional to the power.

This calculation method is mainly used for traction machines.

Therefore for a motor with forced ventilation, one usually considers 6 to 15 m^3/h (0.10 to 0.25 m^3/min) for each power kW in continuous operation.

02 – VENTILATION TYPES

In fact, according to the operation conditions, the power and environment, **the heat losses can be dissipated as follows**:

DIRECTLY:

In this case the air for cooling the windings and brushes enters at one end and leaves at the other one. The **motors are self-ventilated or equipped with motor fans** with filters to trap the dust in the circulating air. It is recommended **that the air should cross the motor from the winding to the commutator direction**, and thus prevent wear dust from being drawn into the windings.

This device may also help to maintain the temperature of the commutator or slip ring to a suitable level, particularly in case of low load operation

BY AN AIR-COOLING SYSTEM:

The cooling air of the windings and brushes is **recycled through filters** (see Technical Note TDS/24) **and an air-air heat-exchanger**. The external air is forced into the exchanger by a motorized fan.

The air-cooling system is often equipped with an auxiliary fan in order to produce overpressure and ensure the replacement of the hot air.

Experience shows that brush wear is often reduced when the air is partially renewed.

In addition the use of a Mersen DustCollector device, which is designed for removing dust arising from brush wear, will help to cool down the system.

DUSTCOLLECTOR, A NEW INNOVATION PATENTED BY MERSEN

Dust extraction system integral to the brush-holder

- No generator modification required
- Standard product that can be customized
- A complete solution for original equipment or retrofit

BY A WATER-COOLING SYSTEM:

The cooling air of windings and brushes is **recycled through filters** (see Technical Note TDS-24) **and an air to water heat exchange**r similar to an automobile radiator.

As in the previous case and for the same reason the water-cooling system is equipped with an auxiliary fan.

Whatever the cooling method the following should be borne in mind:

- The most favorable temperature for a commutator (in operation) is between 50°C and 70°C:
  - A cold commutator does not always build up film under the brush. An excess of cool and dry air leads to the effect of streaking or stripes in the brush tracks as well as irregular wear of the metal of the ring or commutator. It is not recommended to work under 40 °C.
  - The area above 90°C is seldom found in industrial machines. It is generally known that the film is modified due to low humidity; it leads to an increase in brush wear. This situation is becoming more common with newer machines as they get smaller, but should be avoided with appropriate cooling.
- Air that is too cold, besides the disadvantages stated above, will be too dry. In fact, under 2 or 3 g water per m^3 air (see Technical Note TDS-17) the film does not develop and the brush wear increases.
- Excessive humidity also disturbs the brush operation. The skin gets thicker, preferential areas for electric current path appear and generate streaking and stripes on the commutators or slip rings. Disturbances may appear when air humidity gets over 20 g water per m^3 air, but this rate can vary according to brush grades and their impregnations.
- It shall be noticed that, when air is not renewed, oxygen and humidity levels decrease, with an increase in friction and therefore brush wear.

List of citations:
TDS-05: Losses in carbon brushes *TDS-17: Air humidity* *TDS-24: Dust arising from brush wear*

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