Conversion of Open Force-Cooled and/or Self-Ventilated DC Motors to Air-to-Water Heat Exchanger Enclosures

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Introduction

Large DC motors, such as that shown in Picture 1, are still used in steel mills today because of their ability to provide control of low speeds at high torque and their ability to accelerate, decelerate and reverse rapidly under severe conditions. To cool these motors they must be properly ventilated. Typically, the motor enclosures are open force-cooled units with covers mounted on them to guide the cooling air through the machine. These units are usually mounted on bases with pits below them.

Picture 1 - DC mill motor

Problems with low megometer readings due to mill dust and moisture is quite common on DC motors that are located in the mill or in areas with adverse environments. Picture 2 shows common contamination found in DC mill motors.

Picture 2 - DC mill motor contamination

This paper will show how converting these motors from open force-cooled ventilation to air-to-water heat exchangers can keep out mill dust and moisture thereby eliminating problems with low megometer readings.

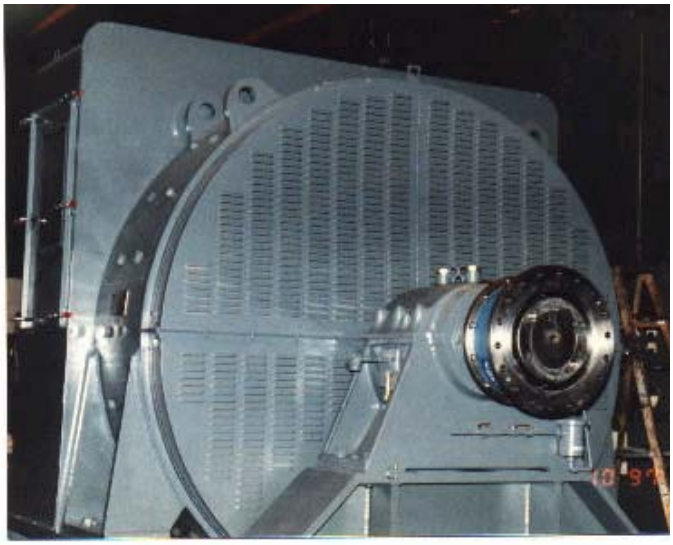
Background

The Timken Company purchased a DC mill motor in June 1996 on the used equipment market for use in their Gambrinus Steel Mill located in Canton, Ohio. Specifications for the motor can be found in Table 1.

Motor nameplate data	Allis Chalmers
	3000 hp
	700 volts
	3430 amps
	350/660 rpm
	Shunt wound
	Type HCC
	Excitation 125/250 volts, 38/18 amps
Temperature rise at continuous 100% load	Armature winding - 40 C
	Commutator - 55 C
Temperature rise at 2 hour 125% load	Armature winding - 55 C
	Commutator - 65 C

Table 1- Motor specifications

Timken asked 3-D Service to install the purchased motor in their Assel Mill application at their Gambrinus Steel Mill. The enclosure for this motor, as originally built, was open self-ventilated. Timken requested 3-D Service to convert it to force-cooled ventilation. Cooling air was brought in from the outside through a filtered guarded system designed by Timken. Cooling air was brought in on the commutator end of the motor and discharged through louvered covers on the drive end of the motor (see Picture 3). 3-D Service designed ventilation ducts and guards on the motor.



Picture 3 - Louvered covers on drive end of motor

After about one year of service, Timken found that the cooler air coming into the motor was condensing on the armature winding causing the motor to have very low megometer readings. Heaters were installed, but they did not properly dry out the unit, and they were not energized at the right times.

In order to raise megometer readings, the motor was being removed and cleaned at least two times per year. The motor came into the 3-D Service repair shop showing signs of moisture and condensation. In addition to the moisture, 3-D Service found that salt used in the processing of the steel was causing damage to the motor, as the salt was another tracking path to ground.

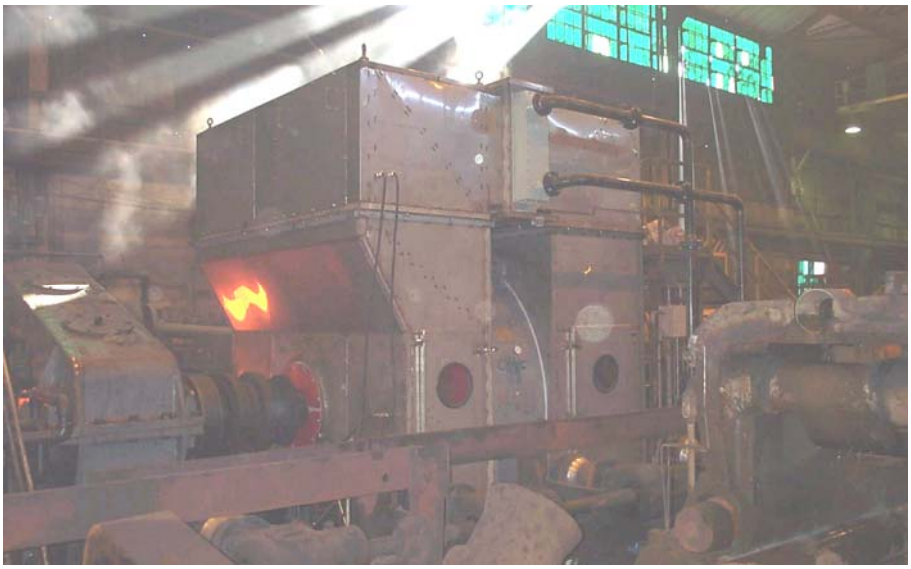
Because of the low megometer readings and frequent maintenance, Timken asked 3-D Service for their recommendation on how to solve this problem. 3-D Service recommended that this unit be converted to a closed-loop system using an air-to-water heat exchanger type enclosure. 3-D Service redesigned the enclosure to be mounted on the top of the motor with an air-to-water heat exchanger.

Airflow Inside Enclosure

The enclosure is comprised of three sections - the drive end cover, commutator end cover and hood. The hood contains the filter bank, air-to-water heat exchanger and blowers. In this arrangement, two blowers set up in parallel configuration force the ventilating air into the drive end of the motor via the drive end cover. Hot air is discharged out of the motor into the commutator end cover. The air is then drawn up into the hood where it passes through a filter bank and then through the heat exchanger. The cooled air then re-enters the blower where the cycle begins again.

Baffles were added in the pit of the motor to prevent the air from circulating only around the frame and not through the armature. An internal baffle covering the field/interpole coils was also designed to guide the air through the armature. The shaft exits were sealed to close off paths where dirt could enter the motor.

Timken had requested that the three sections of the enclosure be made of stainless steel because of the salt attacking the steel and corroding it. By closing off the motor to the mill environment we were able to keep the mill dust and the condensation from forming on it. **Picture 4** and **Picture 5** show the final enclosure design installed at the Timken Company Gambrinus Steel Mill.



Picture 4 - Final design with air-to-water heat exchanger

Picture 5 - End view of final design with air-to-water heat exchanger

Summary

When units in service have a history of low megometer readings due to contamination, converting these units to an air-to-water heat exchanger enclosure should be considered to eliminate this problem. Design of enclosure can mount the heat exchanger on the top, bottom or sides. Modular designs of the enclosure are available where the heat exchanger, blowers and filters are built into one box that is mounted on top of the motor.