UNGROUNDED SYSTEM STATUS MONITORING BY USING HAKEL "HIG" INSULATION MONITORING DEVICES

PART 4: LOW-VOLTAGE SYSTEM UPGRADING IN MINES

This Part 4 in the series of articles describing applications of the "HIG" range of insulation monitoring devices is devoted to an application in mines.

Electricity is irreplaceable in coal mining. Electric power is needed not only to extract coal and transport it to the ground but also to drive all the auxiliary and supporting technologies, such as water pumping, mine gas exhaust and drift lighting. The entire mine system is powered from a ground substation. This power, typically 6kV voltage, is distributed to the workings. Final transformation from the 6kV level usually to 500 and 1000 V occurs in transformer stations. The output stage is an electrical appliance, typically a motor.

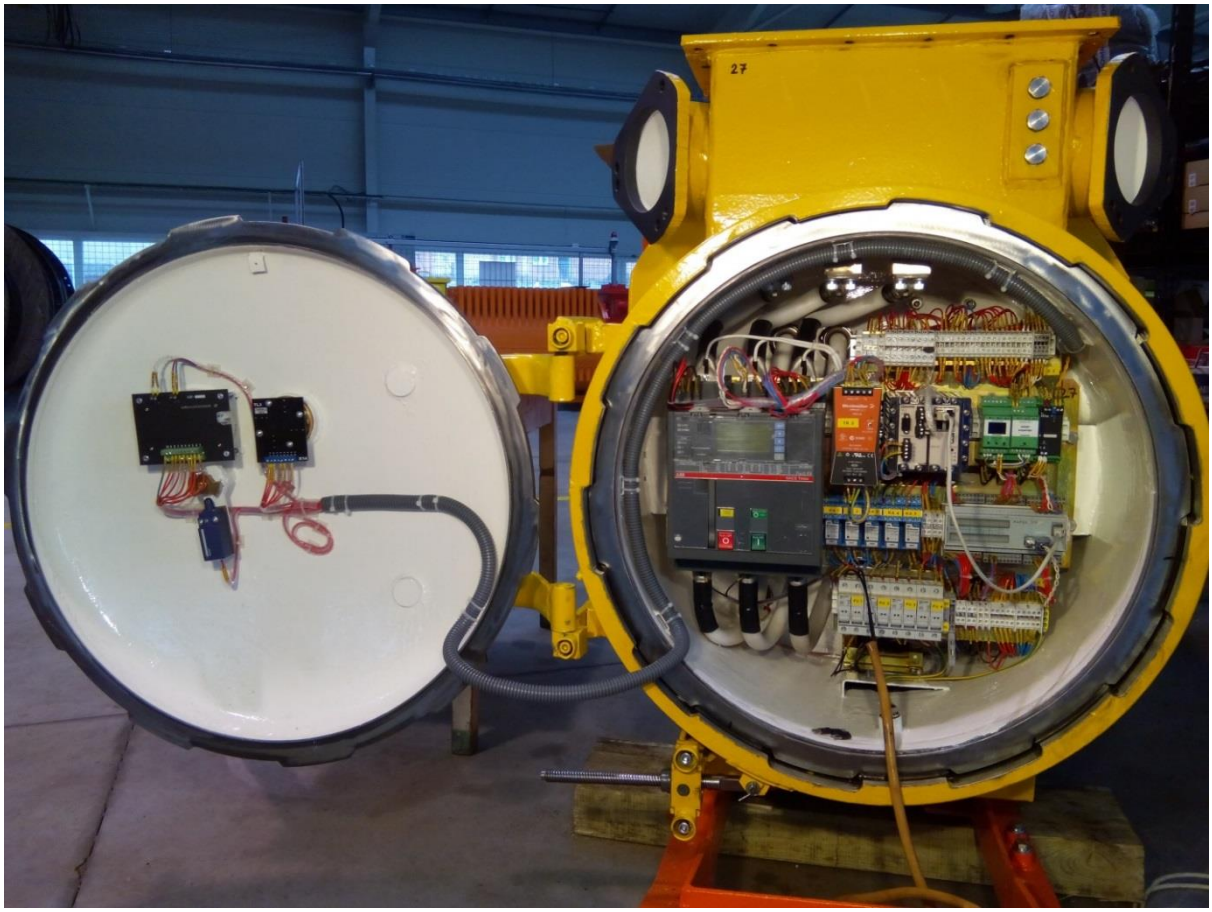

Fig. 1: Completely fitted low-voltage side of an IT3Sb-Q4 transformer station 400 kVA power

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Modernization of the transformer stations

Upgrading or replacement of obsolete transformer stations is a major assignment at existing mines. The mine owner, OKD a.s., outsourced this project, which concerned the IT3Sb 6/05 kV type 315kVA and 400kVA power, initially to Q-ELEKTRIK a.s. Upgrading consisted in complete overhaul of the transformer core, replacement of the disconnectors on the high-voltage side and upgrading of the low-voltage side control system. Knowledge acquired during the project was applied to the design of the new 630 kVA station.

Fig. 2: HIG97 insulation monitoring device, design for Q-ELEKTRIK a.s.

Insulation monitoring requirements

Czech State Mining Administration Regulation No. 22/1989 stipulates that the low-voltage side must be equipped with a monitoring system measuring the outlet cable insulation status both during operation and before switching-on. HIG97 and HIG97/485 insulation monitoring devices (IMDs) manufactured by HAKEL s.r.o. were chosen based on cooperation with REPOS TECHNIK s.r.o. and following successful tests. This device type not only meets the frequent requirement of response time <80 ms, but also includes suitable signalling and control terminals, features reliable operation, is substantially smaller in size than other comparable devices, and offers convenient connection to the system monitored.

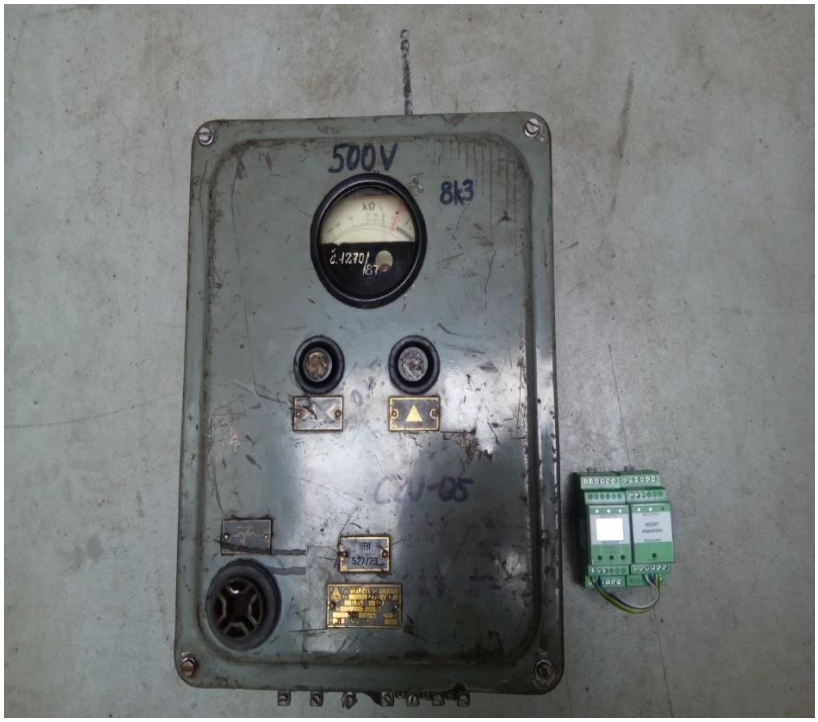

Fig. 3: Comparison between the previous CZU-05 IMD and the new HIG97 device

The HIG 97 device, accommodated in explosion-proof housing, meets the criteria for use in gas-emitting mines. The device is connected to the 500/1000 V AC system monitored via a TL1200 inductor. The critical insulation resistance limit can be smoothly set from 5 kΩ to 300 kΩ by using pushbuttons and the LCD. It is set at 25 kΩ for use at OKD mines. Although the switching-off time is not stipulated by Regulation No. 22/1989, the design requirement was that the modern insulation monitoring device should match, as a minimum, those mine environment parameters that are standard nowadays and are even dictated by local regulations and standards in some countries. The IMD response time <80 ms

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enables the power supply from the 500/1000 V system to be disconnected within 100 ms from the moment the insulation resistance drop below the critical limiting level was detected.

Device connection

Correct performance of the device itself is signalled by the ERR contact, which will switch over if error of measurement or of internal module communication is detected. This contact is included in the undervoltage coil circuit so the built-in output circuit breaker will switch off and disconnect the system power supply if the system is not reliably monitored. In series with the contact is the output of the FA1 MEM relay (with fault memory) which signals the first earth fault until reset by the operator. This signalling relay will not change its status even if power supply on the device is switched off and on again, which implies that the operation of the system monitored can be stopped indefinitely even if the insulation resistance has dropped and then restored above the critical limit and this sequence was overlooked. It is then up to the operator to decide if operation will be resumed or steps will be taken to identify the time and place where the system fault occurred. The fault memory button is located on the explosion-proof housing.

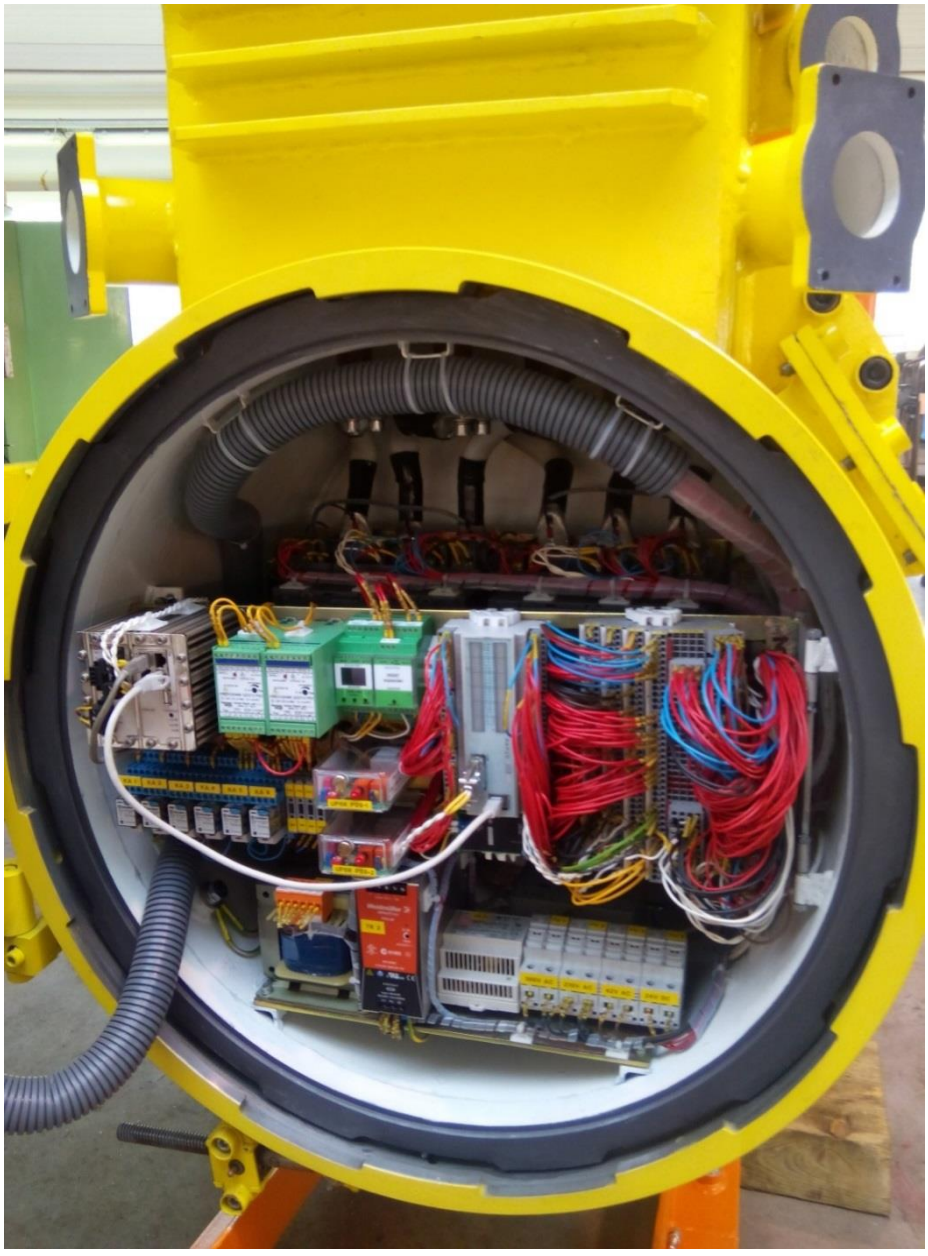

Fig. 4: Detail showing location of the HIG97 device in the 630 kVA IT3Sb-Q6 station

630 kVA transformer

The newly designed IT3Sb-Q6 transformer 630 kVA power contains two output circuit

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breakers on the low-voltage side. The switching-off sequence if poor insulation status is detected follows the order of importance: the first to switch off is circuit breaker 1, to which mining technology is connected, and if no improvement in the insulation condition is detected, circuit breaker 2, powering the fan, follows. This arrangement is based on experience saying that a cable which is towed during the mining process is more prone to damage than a fixed cable.

Communication options

The ability of the HIG97 IMD to communicate with a master microcontroller based on a Profibus type protocol using an RS485 serial line is also made use of within the mine transformer station upgrading projects. Current insulation status data are signalled on the external LCD display on the LV transformer side and can be sent, along with other transformer station status information, via the data network to the control centre on the ground.

Based on practical experience, operation of this modern IMD has been made much more user friendly, primarily through software modifications of the device control system so as to meet customer's needs, and also through hardware modification of some components, especially by expanding the available supply voltage range to the current 90 to 305 V AC or 120 to 400 V DC. To date, about 50 HIG 97 and HIG 97/485 insulation monitoring devices have been in permanent use at OKD owned coal mines.

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