Application Fact Sheet

SIL 2 Ground Fault Monitoring for Hydrogen production

Application report
Electrolysis earth fault monitoring

1. What is the initial situation?

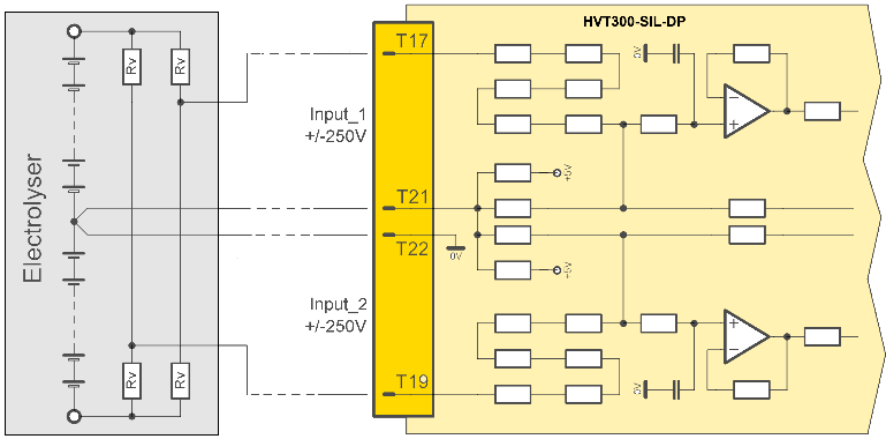
- Electrolysers are used to produce hydrogen, chlorine or caustic soda. Various processes are used for this: AEL/AEM, PEM or SOEC.
- What all electrolysers have in common is that they are not earthed.
- The electrolyser is insulated from the housing, the housing is insulated from the base. The liquid-carrying lines have limited electrical conductivity.
- In the event of a leak, an electrically conductive connection is established between a high potential (e.g. anode or cathode) and PE -> earth fault
- This design also means that an electrical potential can build up on the electrolyser frame at any time, which can lead to an electric shock if touched by an employee and thus to a considerable health hazard.
- This danger is not apparent to employees and operators without measurement.
- Manufacturers and operators of electrolysers therefore want safe, reliable insulation monitoring or earth fault monitoring of the electrolyser in order to eliminate this risk.

2. Solution

- The differential voltage between the electrolyser and earth (PE) can be measured continuously using the Mütec HVT 300/400 DP high voltage transmitter.
- This makes it possible to determine both **whether** there is a safety risk and the condition of the insulation
- In the typical configuration, for example, an alarm signal is transmitted to the PLC / control room from a differential voltage of 60 V (safe touch voltage according to EU standard) (and e.g. a warning lamp is switched with it); from a differential voltage of 110 V, for example, the emergency shutdown (ESD) of the electrolyser is initiated.
- This is usually implemented with one HVT 300 DP (up to +/- 250 VDC differential voltage) or HVT 400 DP (up to +/- 1000 VDC differential voltage) per stack/electrolyzer.
- The voltage difference is measured between the two external electrodes and the center of the stack / earth potential. The target value is 0V, i.e. the stack is in balance.
- The measurement result is output analog via 4-20 mA or via MODBUS RTU to the PLC. In the good state, the output signal is 12 mA.

- The SIL2 relays of the HVT are usually hard-wired and lead to the safety PLC for safe shutdown of the electrolyser
- The lower alarm value is usually displayed in the control room; an automatic alarm signal can be issued in the cell room if the alarm thresholds are exceeded.
- Operators and equipment are protected from voltage peaks as the inputs and outputs are safely galvanically isolated.
- The monitoring system is designed to be safe and redundant. It is durable with an FIT of 331 (safe failure rate)
- Often 1x HVT 300/400 DP per stack for differential voltage monitoring is combined with an additional 1x HVT 300/400 DX for total voltage measurement per stack

3. What needs to be considered during planning and implementation

- Works with all electrolysis processes
- Plan the following:
    - A measuring bridge (two half bridges with two equal resistors each) must be installed
    - The resistors should have relatively high power values due to temperature development
    - The resistors should be temperature-stable (-20 - 120°C)
    - 

- Note the following during implementation:
    - Integration of the SIL relays (REL3 & REL4) of the HVT 300/400 by series connection or in PLC for SIL required

4. Customer benefits:

- No health hazards for employees

- Safe and reliable use, reduces the health risk for employees to such an extent that no special qualifications / instructions / training may be required for working in this area
- Additional information for monitoring the performance of the electrolyser. Changes in the differential voltage indicate that the material flow (e.g. of the caustic solution) is impaired (leaking lines, clogged lines)
- Membrane defects are detected (as these also influence the differential voltage). The operator can react in good time (even if he has not installed a complex individual voltage measurement for each cell). Maintenance / replacement can be planned for the long term without causing unplanned downtime.
- Cost effect: Shutting down/starting up the electrolyser takes a long time and causes high follow-up costs due to production downtime. In addition, a single defective membrane reduces the efficiency of the entire stack.
- Maintenance-free due to SIL2 (in accordance with IEC/EN 61508) and high FIT. As a rule, the systems are only checked every 10 years (proof test interval)
- Easily configurable HVT: alarm values individually configurable via Windows software (2 SIL relays, 2 freely configurable relays)
- High dielectric strength of the device, can be installed at high potential
- Component or system solution available (easy to implement)

5. Restrictions

- Two membrane defects can cancel each other out
- It is not possible to tell which diaphragm may be defective

6. Why our solution is the best:

- R2 - Individual voltage monitoring per cell. Calculating the total voltage in the R2 controller also allows monitoring of the insulation with greater depth of information. Disadvantage: significantly more expensive system.
- Bender - active insulation monitoring, market leader. But no SIL2, active test pulses may interfere with other measurements.

7. References

ThyssenKrupp Nucera standard supplier

If you have any questions or concerns, please do not hesitate to contact us!

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