

# *Rico-Werk*

## **Prometos – High-voltage regulators increase efficiency of electrostatic precipitators (ESP)**

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## **Prometos** High-voltage regulators increase efficiency of electrostatic precipitators

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Only a few years ago, upgrading high-voltage supply units in ESPs was very difficult. This situation changed dramatically due to progress in modern electro-technology and measurement technology. Dust-precipitation efficiency is improving thanks to the newest generation of equipment, and saving electrical energy through a high-voltage supply unit in the filter is now possible. The task of upgrading can be executed within a short conversion period, often even during regular operation.

An example of an ESP control system upgrade within a power station block is described below:

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### 1.0 Project definition

#### 1.1 Equipment data

Behind a coal power station boiler with an electrical capacity of 900 MW, two ESPs are used to remove the dust in raw gas. The gas quantity amounts to 2,800,000 m<sup>3</sup>/h. The filters are supplied by 32 high-voltage rectifiers (T/R-sets) on the precipitator roof with following electrical datas:

Nominal mains supply	380 V, 187 A
Nominal high voltage	85,000 V
Nominal output current	1.12 A

The control room is placed directly under the filter on the first floor and contains a total of 42 electric control cabinets divided in:

- 2 x 16 pieces for the T/R-set control
- 2 x 04 pieces for the control of rapping motors and the insulator heatings
- 2 x 01 piece for general control and measurement

The year of manufacture of the equipment is 1975. An urgent upgrade to the controls is required for the following reasons;

- the availability of used controls is rapidly decreasing
- the possibility of eventual repairs is not guaranteed
- modern Prometos closed-loop controls increase dust-removal efficiency
- modern Prometos closed-loop controls save energy which pay off in a very short period of time.

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### 1.2 Decision

The 32 controls for the high-voltage rectifiers should be replaced using Prometos closed-loop controls. The complete measuring and remote action component must be also renewed because it is part of the Prometos units.

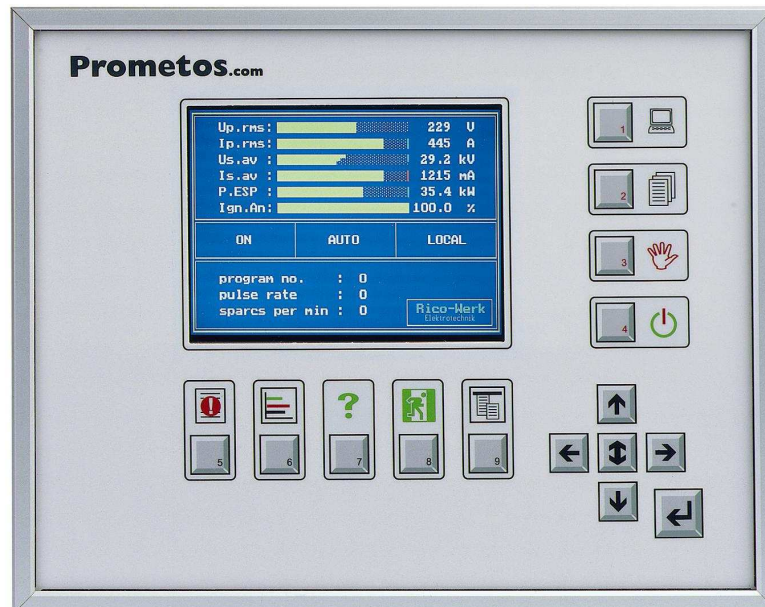


Figure 1: **Prometos** closed-loop control, picture by *Rico-Werk*

Since all equipment was in very good condition, the power electronics and power current components are used in future. Consequently, the electronic control cabinet can be retained with the power components, including the overall cable installation. This procedure greatly reduces the investment costs. The conversion can be completed in a few days and can be done in part during regular operation.

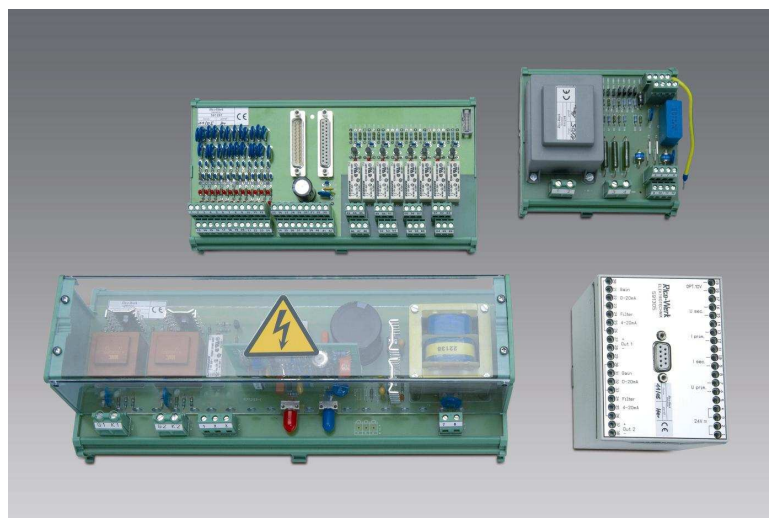


Figure 2: **Prometos** measuring and remote components, picture by *Rico-Werk*.

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The controls for the rapping motors and the insulator heatings were already upgraded 12 years before to programmable versions (PLC) Type S5. Now the corresponding Programmable Logic Control type S7 with touch screen panel should be used. This conversion should also be carried out amongst the retention of the overall cable installation. The high-voltage rectifiers themselves are kept in their original version.

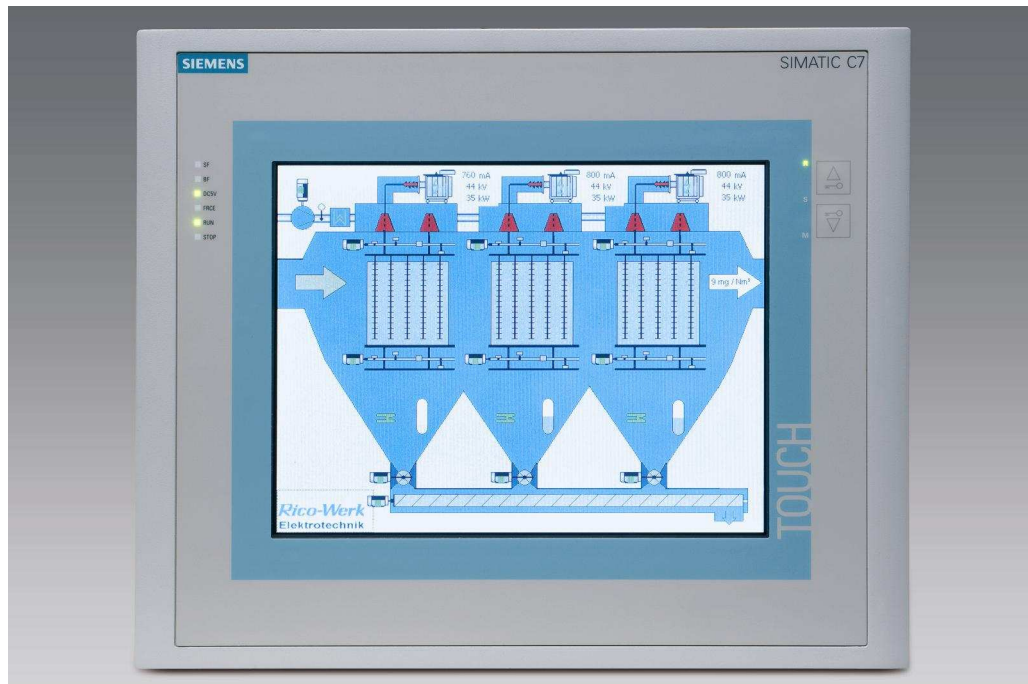


Figure 3: C7 Control with touch screen panel, picture by *Rico-Werk*.

## 2. Implementation

The upgrade was carried out in 3 stages:

1. A tentative installation of 16 Prometos closed-loop controls on both ESPs so that a dismantling in the original condition could be carried out at all times. Comparison measurements between the two ESPs. Each filter is supplied with a separate clean gas dust concentration measurement.
2. After the outstanding results final installation of the Prometos controls in the control cabinets. At this juncture, only the control cabinet door is renewed because it must have other holes. One man-day is required for each control cabinet installation. The installation is carried out with regular filter operations. Only those in the building range are switched off.
3. Exchange of the PLC controls. The modern C7 controls are equipped with specifically produced connection cables. This allows users to keep in place all other remaining cabling. Prometos regulators, C7 controls and power plant control center are linked via a serial data bus (profi bus). It is used to transmit the measuring values and the remote control originating from the control center.

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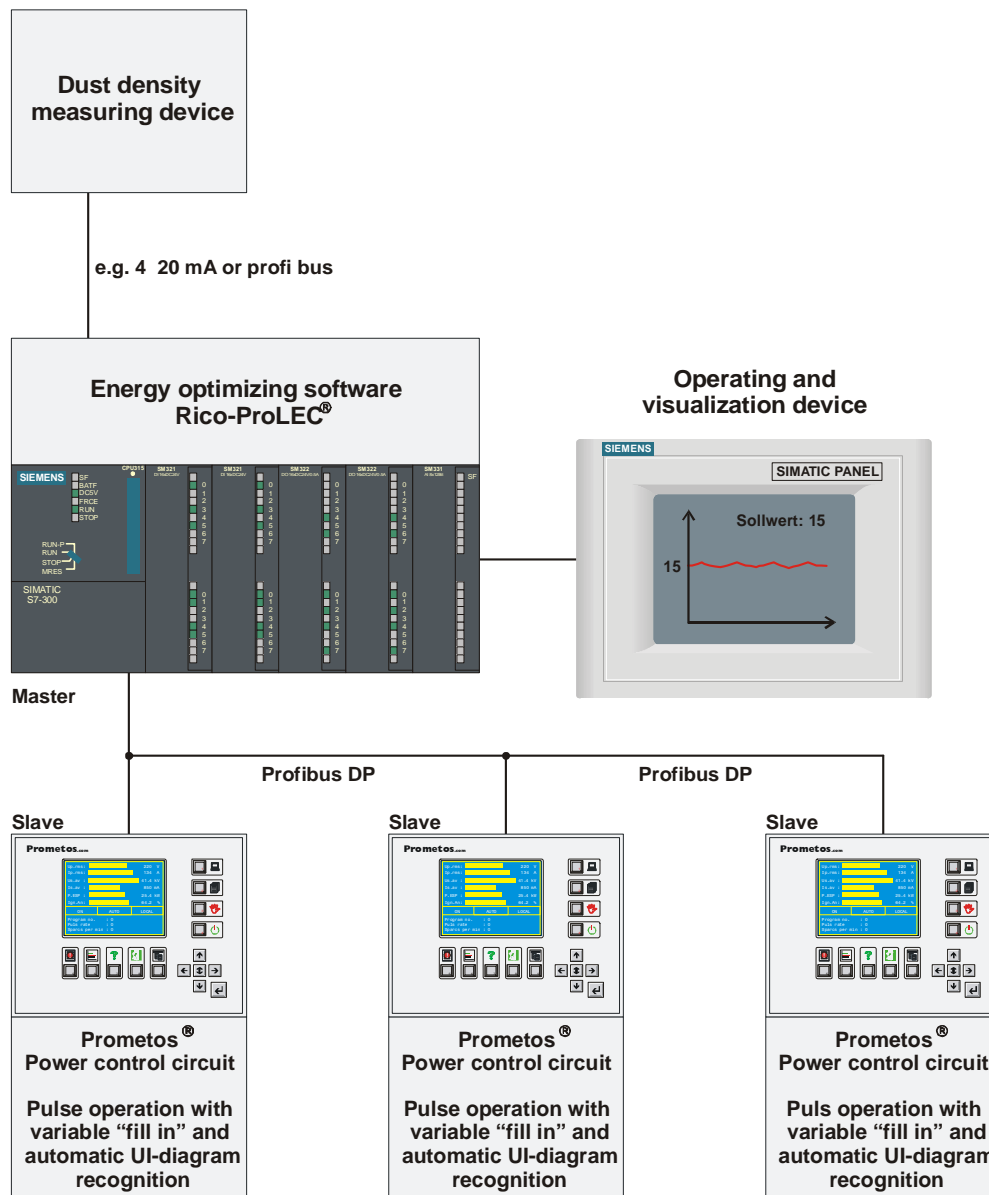


Figure 4: Energy optimizing software **ProLEC** (block circuit diagram)

### 3. Why Prometos ESP high-voltage controls improve dust precipitation

The higher the electrical field strength, the better the dust removal effectiveness.

This undisputable statement governing electrostatic precipitator performance was the driving factor behind the development of Prometos' ultra-modern voltage regulator. Thanks to the consistent utilization of high performance electronics (Pentium Processors) the company succeeded to develop a device series that has since proven itself in countless applications.

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With 32,000 measurements per second the extremely fast measuring value recording device provides a depiction of the electrical conditions within a filter zone by recording voltages and currents within the filter. These measurements provide the basis for graphic depictions of the electrical parameters on the LCD displays as well as for the calculation of the rms values, the mean values, the maximum and minimum values and for the calculation of the electrical power. These calculations are made within one thousandth of a second and are calculated 100 times per second. The results are the foundation (actual values) for the regulation algorithms stored in the software.

Thanks to the high speed and precision of these recordings it is also possible to attain maximum possible electric field strengths in the filter zone and to consequently improve the removal of dust.

### 4. Why energy optimization software **ProLEC** saves electric energy in the operation of high-voltage power supply.

High performance energy optimization software ProLEC (Process Low Energy Control) was installed in addition to the Prometos filter voltage regulators. It works in conjunction with the dust density measuring device, the touch screen operating unit and the S7\_PLC, which also controls the rapping motors and insulator heaters. The energy optimization automatically ensures that the high-voltage power supplies attain maximum filter efficiency while using minimum amounts of energy. The optimization is precisely aligned with the functions of the Prometos regulator and translates years of experience into a dependable system.

As soon as a Prometos regular receives a command to reduce power from the optimization software, a periodic pulse operation of the filter current is produced, within which small and larger electric power half waves alternate. The ratio is calculated by Prometos in such a way that the performance target value is attained. The filter voltage produced by the mode of operation generates a more effective precipitation than conventional equal filter voltage.

### 5. Conclusion

Upon completion of the 3<sup>rd</sup> stage of modernization, start-up operations and the utilization of energy optimization software ProLEC, a substantial improvement of dust separation was attained, even if the coke was otherwise "complex". The energy savings achieved in terms of electrical power supply to the filter while maintaining equivalent dust separation performance indexes is 75%, in this example 600 kW (2 x 300 kW). It is therefore guaranteed that the modernization expenses will be amortized after just a short period of time.

Similar results have in the interim been achieved in a large number of modernization projects utilizing Prometos high-voltage controls. A test with a temporarily installed device may be performed on each plant without any major expenses at any time – upon request – which can be uninstalled just as easily. This test option offers a risk free alternative for this investment decision.

### 6. Further reading

- 1) VDI Guidelines, VDI 3678, 1998  
Electrostatic Precipitators, Process and Waste Gas Cleaning
- 2) Brauer Handbuch des Umweltschutzes (Environmental Protection Manual), Part 3,  
Behandlung von Abluft und Abgasen (Treatment of Exhaust Air and Exhaust Gases),  
Springer Publications
- (3) High Voltage Supplies to Electrical Filter Equipment (Hochspannungsversorgung von  
Elektrofilteranlagen), Rico-Werk, Presentation at the Haus der Technik, Essen