Easier handling and enhanced system availability by microcontroller-based burner control unit

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When considering components for equipping heating equipment, the focus is frequently on procurement price and technical characteristics. However, a differentiated analysis of the entire lifecycle indicates that factors such as effective project planning and operational safety and reliability have a major impact on lifecycle costs and should also be taken into consideration in selection. Modern, microcontroller-based burner control units can substantially enhance the ratio of investment to benefit gained.

It is necessary to consider expenditure and benefit for the entire service life of the product in order to obtain an objective result when selecting equipment components for heating installations. Frequently, the purchase price with defined technical features is the focus when constructing an installation. This also includes the effort and expenditure for project planning, installation and commissioning, as well as the component prices. For example, a more extensive costing process, besides covering energy costs, will also cover outlay on downtimes and maintenance (**Fig. 1**). Program-controlled burner control units on the basis of fail-safe operating systems offer the required level of flexibility and optimised diagnostic and setting options for favourably influencing the crucial cost drivers and generating additional added value, besides offering extended functions.

Basic structure

Normative requirements applicable to burner control units are stipulated for industrial thermoprocessing equipment within the framework of the Harmonised Standard further to the Gas Appliances Directive, EN 298, Automatic Gas Burner Control Systems for Gas Burners and Gas Burning Appliances [5]. Conventional automatic burner control units incorporating discrete technology guarantee the required safety by appropriate design of the internal circuitry. A failure modes and effects analysis (FMEA) is conducted to verify that a safe state of the heating equipment is ensured even if components fail. This technology allows effective implementation of the basic functions for burner operation.

Modern, digital burner control units (**Fig. 2**) use a self-monitoring system comprising two microcontrollers in combination with a fail-safe operating system (**Fig. 3**). A higher-level burner control program performs the control functions in the form of a temporal sequence as a function of input signals. The behaviour can be adapted to the relevant application with corresponding user parameters.

The options of a program-controlled system allow extensive, simplified implementation of functions of the protective system on thermoprocessing equipment. Important information on this is provided in EN 50156-1, Electrical Equipment for Furnaces and Ancillary Equipment [6]. Consequently, pre-purge upon furnace start-up necessitates interplay between the central furnace control, air volume control, time controller and the air control valve on the burner. An intelligent pre-purge function of the burner control unit allows the air supply to be activated with fail-safe prevention of burner start.

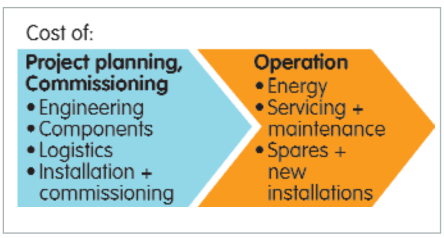

Fig. 1: Product lifecycle

Fig. 2: Burner control unit PFU 700

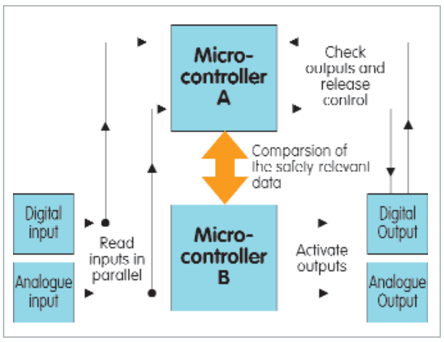

Fig. 3: Architecture

For reasons relating to availability, a temperature monitor can be used to monitor burners with high combustion chamber temperatures. EN 746-2, Industrial Thermoprocessing Equipment, Part 2: Safety Requirements for Combustion and Fuel Handling Systems [1], defines high temperature operation at furnace wall temperatures upwards of 750 °C for this case. Initially, the burner control unit monitors the burner during the heat-up process, for instance with an ionisation or UV sensor. An external, fail-safe temperature monitor then takes over the monitoring function as of a temperature of 750 °C. The flame control function of the burner control unit is deactivated for this purpose via a corresponding control input.

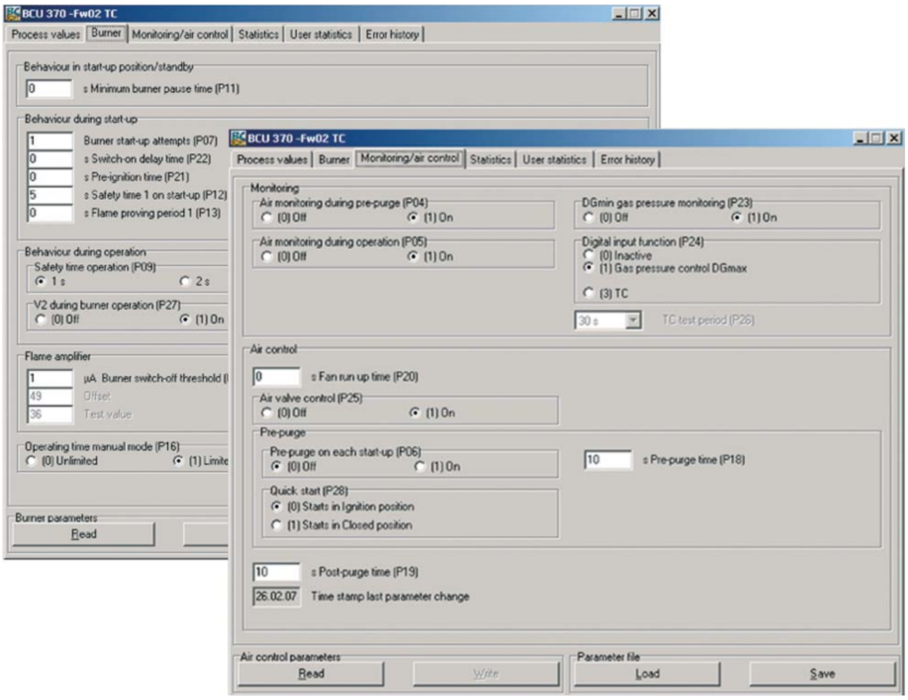

Fig. 5: Individual programming with the BCSoft programming software

Project planning and system integration

The specific requirements of the various types of heating equipment in respect of burner control units are covered by selection of appropriate device types and parameter settings. Conventional product documentation purely containing device descriptions is not very suitable for optimally utilising the diverse options. An effective design that also complies with the applicable standards can be achieved only by respecting suitable procedures starting with application descriptions elaborated in advance, followed by the selection of appropriate equipment and then the definition of the individual settings. Appropriately structured, electronic documents with linked cross-references to detailed descriptions of the relevant functions and project planning information are suitable for this.

Configuration programs assist this project planning process with stored object dependencies (**Fig. 4**).

Apart from purely functional integration, it is the aspects of electrical-engineering and IT system integration that play a major role within the framework of a total cost assessment. Interworking via fieldbus systems such as Profibus-DP allows low-cost connection of the burner control units to the higher-level process control system, for example on the basis of programmable logic controllers, PLCs. This allows the effort and expenditure on input and output modules in particular to be substantially reduced, besides reducing wiring costs. The extended communication options permit transmission of activation signals and feedback signals and also ensure the availability of additional information at the management level, such as display of the flame signal.

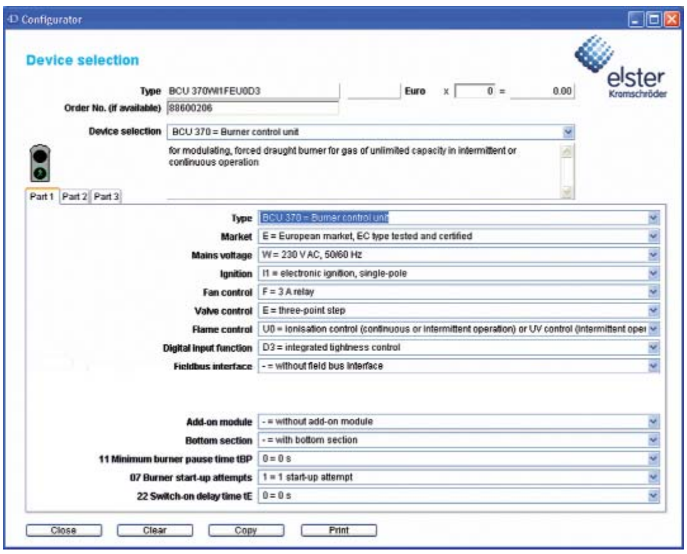

Fig. 4: PC-based product selection tool with stored object dependencies

Logistics

Invariable, hard-wired sequences and time responses incorporated in the unit necessitate a large number of stocking variants so as to have available components for construction of new installations and for spares. By contrast, programmable functions with only a few basic variants ensure adaptation in line with demand (**Fig. 5**).

Moreover, integrating functions that have been implemented by separate devices to date also reduces the number of system components required. This diminishes expenditure and effort on ordering and stocking, besides cutting system costs. For instance, distributed burner control units in robust, industry-standard housings contain the electrical connection system, the ignition transformer and the user interface for operator control and status display, in addition to the actual flame monitoring system.

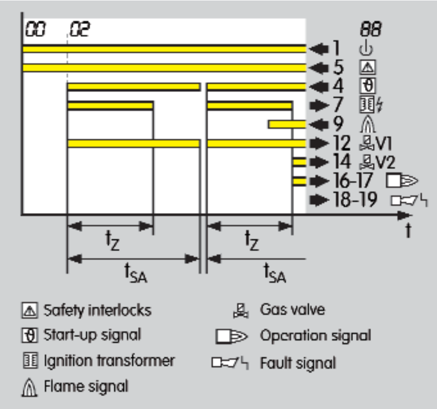

Fig. 6: Several start-up attempts on BCU 400

Installation and setting

An optimised connection system and effective setting tools meet the requirements for fast installation and commissioning. Spacious wiring chambers with distributor terminals allow direct connection of control lines with no further sub-distribution panels. Installation of burner control units in compact 19" racks requires precise wiring of the plug connectors of the individual burner control units. Prefabricated module subracks with an integrated backplane transfer the signals to generously dimensioned push-lock terminals. This enhances wiring reliability and substantially reduces time required.

Manual mode of the burner control units ensures that the burner equipment can be commissioned and set independently of the central control system. After activation, the burner control unit responds to the presets of the operator on the unit who can manually activate various operating steps on the operator-control unit.

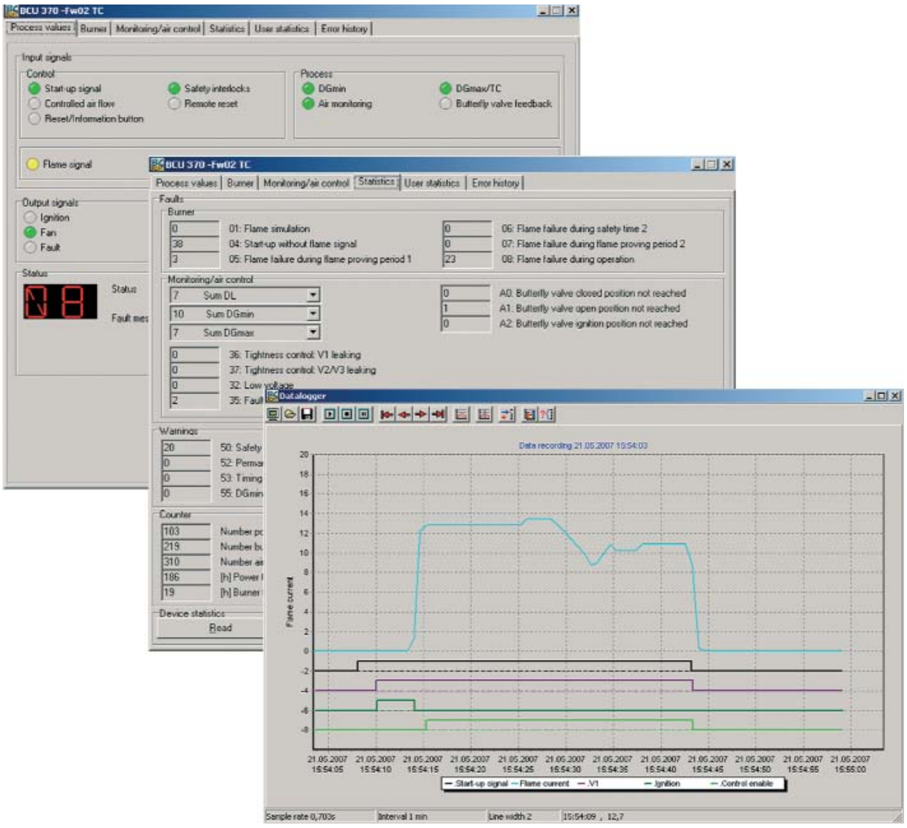

Fig. 8: BCSoft diagnostic software

The detailed requirements applicable to setting of the burner control unit frequently do not become clear until commissioning of the system. For instance, in the case of the UV-controlled systems, it is sometimes necessary to adapt the switch-off thresholds for the flame amplifier. This makes it possible to compensate for interference from other burners in the furnace chamber that would lead to a reduction in burner availability.

All parameters are summarised in a log file that fully documents the current settings. The optimised unit settings can be transferred quickly to other burner control units using the programming software.

Operational reliability and safety

Optimised behaviour of the burner control unit may substantially enhance system availability. Consequently, the Application Standards EN 746-2 [1] and EN 676, Automatic Forced Draught Burners for Gaseous Fuels [2], allow automatic restart of the burner under certain conditions after a flame failure.

Restart from operation compensates for brief-duration flame signal fades on burners that occasionally demonstrate an unstable flame behaviour.

For instance, if starting difficulties occur with long pipes between gas valve and burner, further start-up attempts may ensure reliable burner start (**Fig. 6**).

The safety time during operation defines within what period subsequent to a flame signal failure the gas valves must be deactivated. EN 746-2 [1] refers to EN 298 [5] in respect of the flame safeguard. The Standard defines one second for this. Flame amplifiers incorporating conventional circuitry respond more sensitively to current fluctuations in the case of low flame signals than specified. Flame amplifiers incorporating digital circuitry allow precise utilisation of the prescribed safety limits to achieve optimum availability.

Diagnosis and servicing

Simple automatic burner control units offer the user only a brief overview of the operating status. However, this does not suffice to localise the cause of a

Fig. 7: Burner control unit BCU 400 with integrated status displays

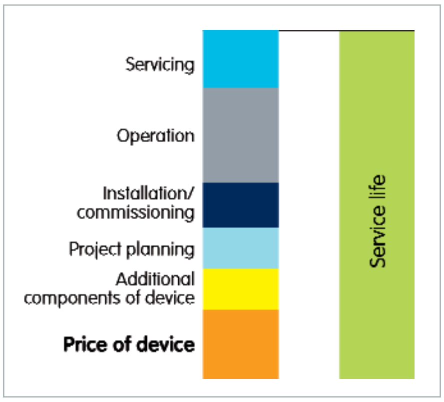

Fig. 9: Total cost assessment

fault quickly and effectively and take the corresponding remedial action in fault situations. An informative display (**Fig. 7**) allows the current status of the burner equipment to be displayed directly and indicates to the service technician the particular operating step in which a shut-down occurred. PC-based diagnostic software allows an extended display of the system behaviour. Direct access to the device allows the current status and the contents of the error history memory to be read out and clearly displayed (**Fig. 8**). A line recorder function on the PC also documents the characteristic of selected input and output signals as a function of time. Differentiated measures for system optimisation can be taken on the basis of this depth of information.

Economic feasibility assessment

The analysis within the framework of the relevant lifecycle steps forms the basis for more precise costing. This necessitates identifying and rating the relevant cost drivers. This analysis will be customer-specific and will include factors such as the costs of project planning time, electrical wiring and system downtimes. On this basis, it is possible to determine the optimum components that, in total, achieve the highest added value (**Fig. 9**).

Literature

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