UTCAS

–THE COMPLETE SOLUTION FOR CONVERTER PROCESS MANAGEMENT

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Introduction

The UTCAS system has been developed by UHT – Uvån Hagfors Teknologi AB – previously Uddeholm Technology AB. UTCAS is a highly sophisticated computer system especially designed and developed for converter refining processes. The UTCAS concept combines effective real-time process control system with advanced tools for process design and production evaluation, thereby providing the complete solution for converter process management.

The UTCAS solution includes modules and system tools for real-time process control as well as the pre-processing phase where the process is designed prior to production and for the post-processing phase where the process and production is evaluated. The results and conclusions from the post-processing phase can be used as feedback for future improvements in process design.

The real-time process control module is designed as an integrated unit with established communication links to the surrounding systems for planning raw material handling and sample analysis. The UTCAS also provides an OPC based tool for easy configurable connection to the level 1/PLC system.

By taking advantage of all UTCAS modules, it is possible to drastically increase productivity, improve quality and, at the same time, lower production costs.

Pre-processing

UTCAS provides an application called Melt Shop Practice (MSP). With this tool, it is possible to design tailor-made process routes - or practices - for each different steel grade. In fact, several alternative practices can be generated for each grade.

The total process is regarded as a sequence of different steps, blow steps (figure 2), addition steps (figure 3) and action steps e. g. a steel sample or a temperature measurement. Each step can be defined with different properties such as gas mixes, temperature limits and materials. The start and end of the steps are controlled by defined conditions such as volume of O2, T>, C< and fixed times.

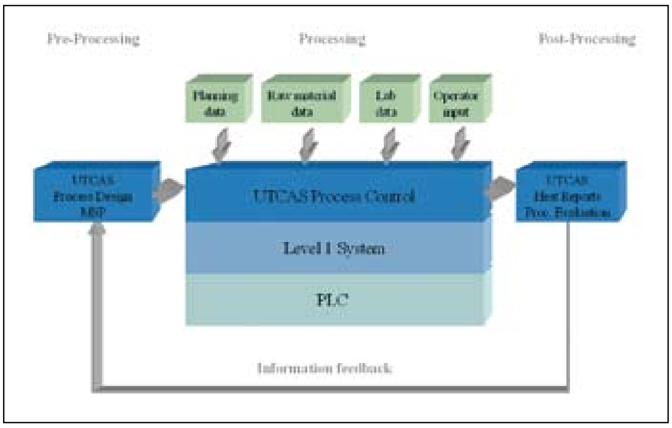


Figure 1. Complete process management.

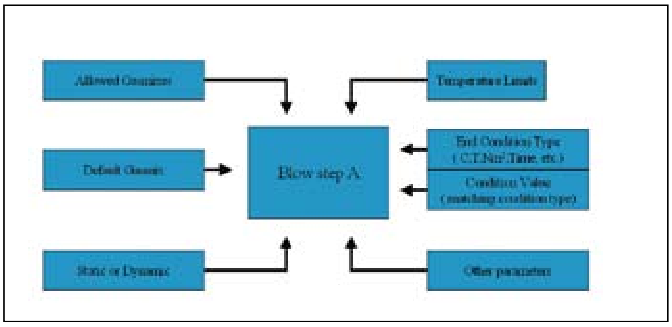


Figure 2 - Blow step structure

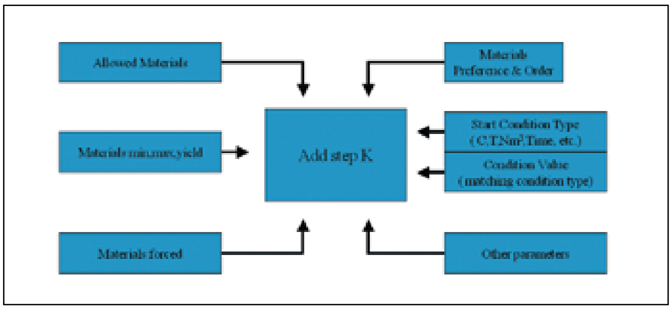


Figure 3 - Addition step structure

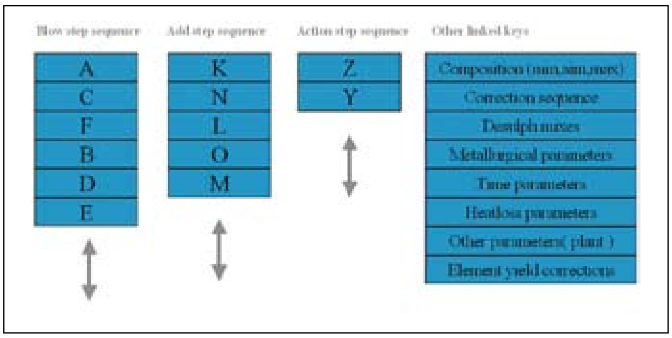


Figure 4 – Practice design

With the MSP tool, any number of steps can be created as building blocks and then put together into sequences in various combinations (figure 4).

In addition to the sequences of steps, each practice will hold references to a number of other configurable definitions such as chemical composition (min, aim and max) and different model parameters. The model parameters allows the metallurgical and thermodynamic calculations to be tuned in and adjusted to the site specific situation, for instance the size and geometry of the vessel, the capacity of the valve station and of the material feeding system.

This way of constructing practices gives the process engineers or metallurgists an extremely flexible and powerful tool to define the best possible process routes for each and every grade. Specific practices can also be designed for re-blows and other special cases.

At any time while designing a practice, the user can call for a test calculation of the current configuration. The test calculation will use the same advanced metallurgical models that are used in the real-time process control environment to optimize the process plan and simulate the result of the designed practice. The result will be displayed in a HMI that is very similar to the one that the operator will use when processing the heat, see figure 5.

When the process engineer is satisfied with the practice, it will be stored in the database and ready to be used for future production.

Processing

To process a heat, the defined practice for the current steel grade is selected from the database. The real-time process control system then automatically executes a process optimization.

The practice serves as a framework for the process optimization where the calculations consider the current state of the heat regarding mass, temperature and chemical composition and the availability of gases and materials in order to move from the start conditions to the defined targets in the most efficient way. The result from the optimization is thereafter displayed to the operator (figure 5).

Material amounts and conditions for additions can also be changed in a similar way.

The operator can also at any time initiate a new process optimization that will consider the changes made in a way so that the final targets are met. If, for instance, the operator wants to increase the required final steel mass, the process optimization will adjust the material amounts in order to reach the desired mass and at the same time keep the chemical composition.

Tracking and prediction

The integrated metallurgical and thermodynamic models represents the inner core of UTCAS.

The models are based on results from university research and also on many years of empirical trials and studies. All important oxidation and reduction reactions as well as sulphur and nitrogen balances are covered.

The models are designed and configured to continuously and repetitively calculate the chemical composition and heat balance during the entire process and will in this way serve as instruments for the tracking and prediction functions (figure 6).

The tracking function will at all times keep the current heat state with respect to mass, temperature and chemical composition. Added gases and materials, temperature measurements and sample results are used as input data over time.

The prediction function uses the current heat state as a starting point and uses the defined practice and process plan to generate a list of future heat states until the end condition of the final blow step.

The operator has many options for viewing the calculated results. Figure 7 gives an example of C and T over time. The dotted part of the lines represents the predicted future.

During processing, the calculated current heat state is continuously evaluated by the system in order to find out if the start- or end condition for any step is satisfied – for instance %C < 0.3. If so, the system will execute the step in the meaning that the correct set-points are written to the PLC – for instance the required bottom gas mix.

Also, the predicted future heat states are used to initiate the weighing of material in due time before the actual start condition for the addition. The operator is also alerted in due time before planned sampling or temperature measurements.

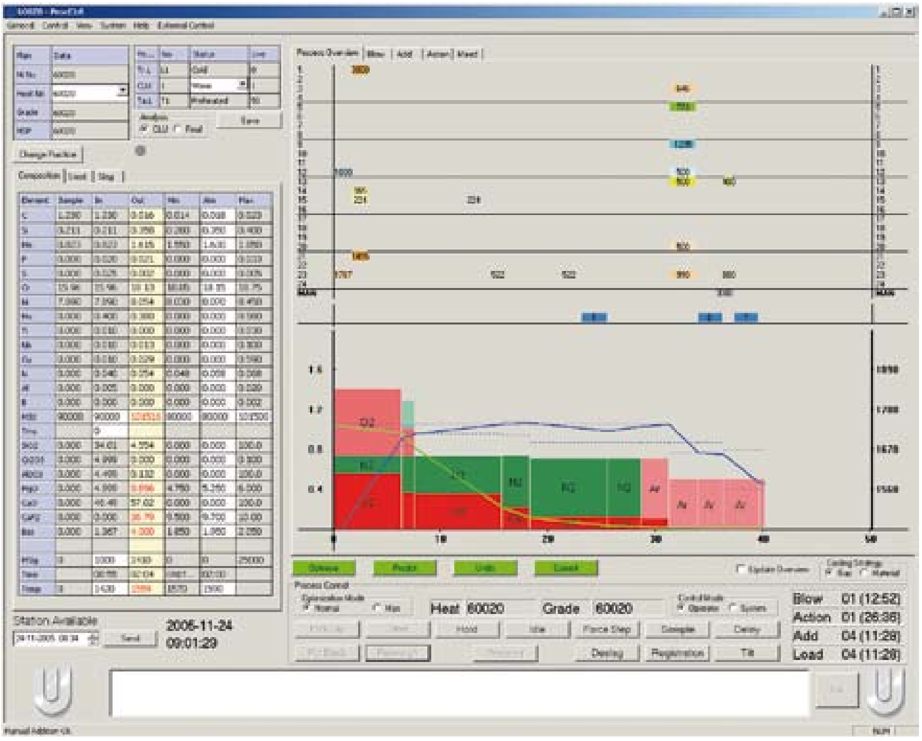


Figure 5– Operator screen sample

Normally, the operator will accept the result from the process optimization and start process the heat. UTCAS will then initiate gas blowing, material weighing and addition according to the optimized process plan by giving set points to the PLC. The process is thereafter automatically run by UTCAS and the operator can monitor each event on the screen. The operator is at any time able to make changes to the process plan.

The required changes to e. g. blow another gas mix in the actual or any future step, or change the start- or end conditions for blowing, are easily entered and activated.

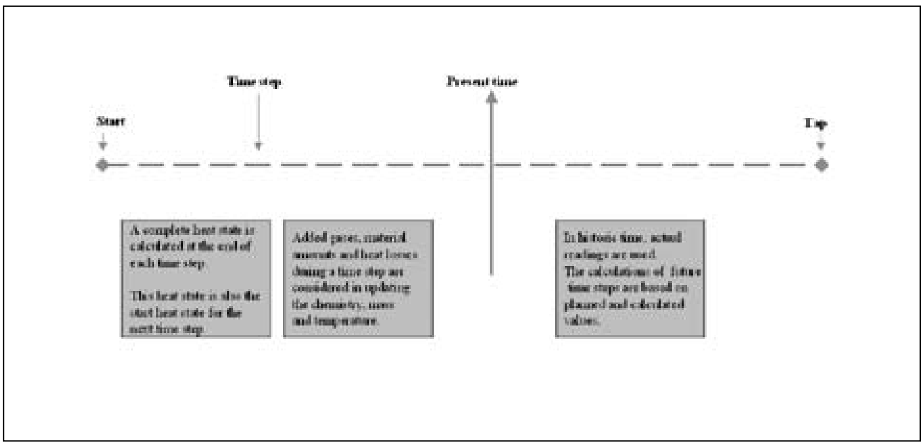


Figure 6 – Tracking and prediction principle

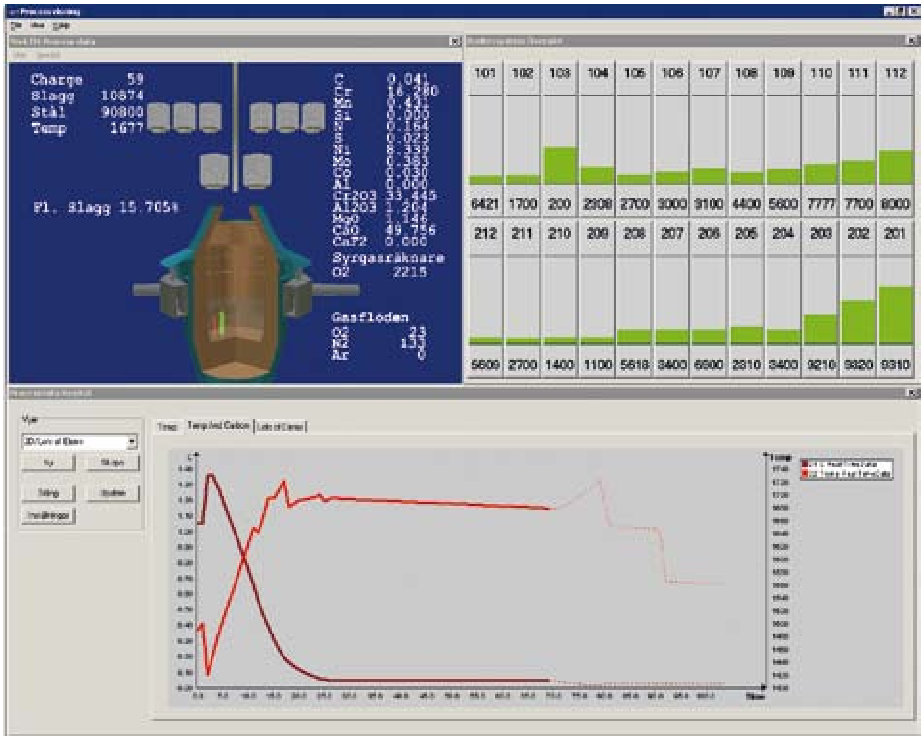


Figure 6 - Tracking and prediction view

Temperature control

As mentioned previously, the process optimization optimizes the required process gases as well as the material amounts (including reduction agents) in order to satisfy the final aimed conditions with respect to chemical composition and mass.

In addition to this, the process optimization will also control the temperature over time. For each blow step, it is possible to define temperature limits. The process optimization includes several functions to find solutions in order to adjust the steel temperature to be within these limits.

Dynamic blowing. Adjustment of the gas mix (oxygen/inert ratio) within the step

Placement of calculated material additions along the process time line in order to achieve cooling effects where best needed.

Calculation and addition of extra addition cooling where required.

The practice definition tool allows the metallurgist or process engineer to pre-define how the options shall be handled by the process optimization. In this way, the system will be able to automatically calculate a process plan where the temperature is within the defined limits during the entire process. This control function will also include the final aimed tapping temperature.

Alternative practices

Several alternative practices can be defined for each steel grade. The operator can at any time switch from one practice to another depending on the current situation. Typically this function can be used for re-blowing or re-planning but could also be used for economic reasons,where one practice can be designed for maximum dC/dT and thereby a bit more expensive on reduction agents, while another practice option can be designed for saving material. The current casting situation will then determine which alternative route to select.

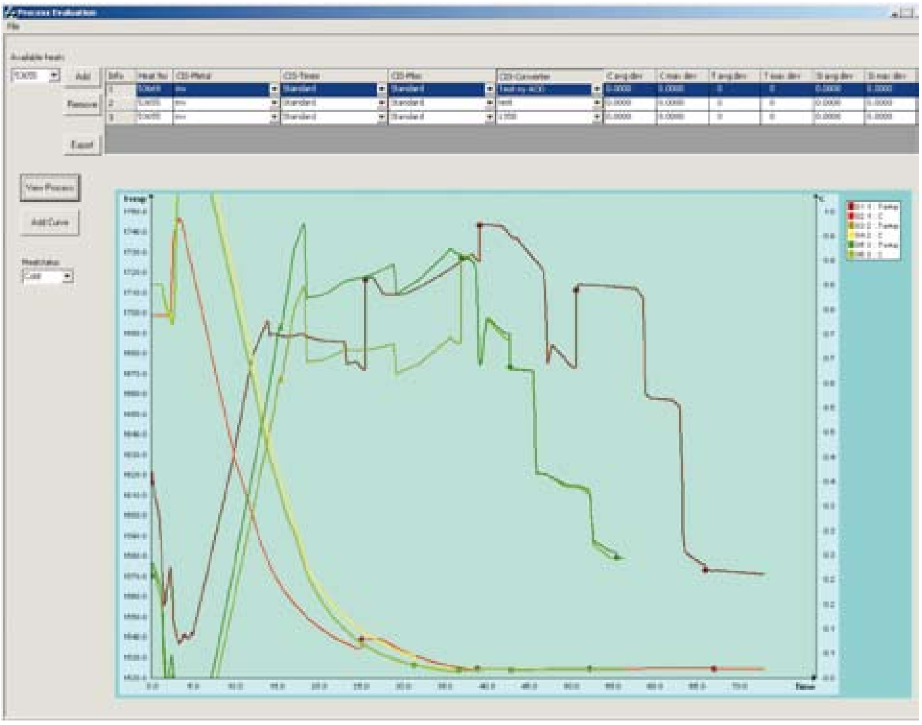
Post processing

During processing, all process data are stored in detail into the system database. Even the operators selections and changes are logged. The stored data are used to generate complete heat reports and all data are also open for export business warehouse or historic databases.

A very important post processing component is the Process Evaluation tool. The Process Evaluation tool serves as a site specific, knowledge base for process corrections and development over time. This tool makes it possible to run "replays" of previously pro-

cessed heats, helping the process engineer to further improve and tune the process. The tool also enables tracking of deviations – both random and systematic.

Figure 8 shows the evaluation of temperature and carbon curves for three different heats. The model parameters can be temporarily changed and the curves can then be recalculated in order to evaluate the effect of the changes.



Recent installations

The latest version of UTCAS is today in successful use at the Outokumpu plant in Avesta, Sweden and also at both converters at the Acerinox Columbus plant in Middelburg, South Africa. At these sites, UTCAS has contributed to a fully automated process of 100% of the production – all in all well over 1 million tons of stainless steel per year.

A light version of the UTCAS has also been installed at the North American Stainless plant in Kentucky, USA, where it serves as a powerful tool for short and long term process development.

UTCAS for simulation and training

UTCAS also offers the possibility to be used as a training studio. The system can easily be configured as an off-line process simulation environment – much like a flight simulator. Different practices can be generated and "processed" as actual heats in real-time.

The full scale environment can then be used for two interesting purposes:

To simulate new practices for new steel grades prior to the first physical heat.

To serve as a training studio for operators and engineers.

Great cost savings can be made by avoiding expensive mistakes in the subsequent real production.

Simulation environments are configured and used both at the Avesta and the Middelburg plants.

Conclusions

UTCAS offers a complete solution for the converter process and has been proven to highly contribute to improved quality, increased productivity and reduced production costs.

The ability to pre-process with the MSP (Melt Shop Practice) tool provides an effective instrument for designing best-practice - tailor-made - process routes for each different steel grade.

The real-time process control system can run the process fully automatically from start to end, based on the pre-defined practice, ensuring that the best-practice process route is repeated for heat after heat. During the process the operator is provided with powerful support functions to make quick decisions and avoid mistakes.

The process optimization function can find the most economic solution with respect to gases and materials in order to reach the final conditions and keep the process temperature within given limits.

All production data are stored in a database for later verification and follow-up. The storage of the production data combined with the Process Evaluation tool is an important component of UTCAS and enables both short and long term process development.

The simulation feature for training purposes further contributes to UTCAS unique solution of process management and will lead to fewer mistakes and thus provide great cost savings in subsequent real production. ■