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Optimized by:

CAPS™ V5 Software Suite

Get the Most Out of Your Anneal Shop

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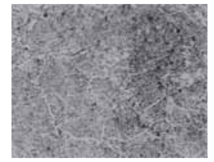
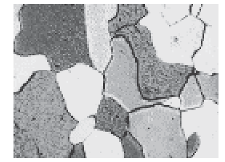



LAB MANAGEMENT MODULE

Efficient collection, retrieval, and analysis of lab data are important parts of a successful quality system. Entec's **Lab Management Module** makes the process simple. Easy-to-use screens are employed to collect data during sample preparation and testing. Reports provide correlation between the annealing process and material properties.

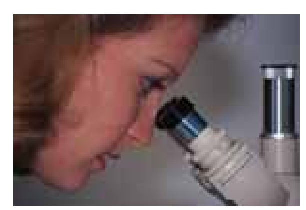
Metallographic Data

Metallographic data is collected in two steps. As a mount is prepared, data is entered with mount position, identification, and sample location. The mount is saved for later access when the mount is evaluated. Once the mount is prepared and ready for evaluation, the mount number is selected on the metallographic results screen for data entered during evaluation.

Mechanical Property Data

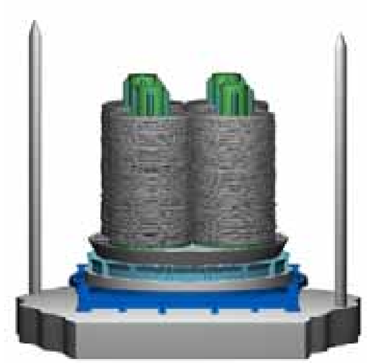
The Lab Management Module allows for entry of mechanical property test data, or it can be directly interfaced to lab equipment to receive test results. The system is designed to collect most standard mechanical property data. Interface to the corporate system for automatic release of material for shipping or the next operation. Material Certifications can automatically print when material meets the order requirements.



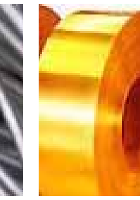


Reports

This module also adds many reports to the existing list of CAPS™ reports. Daily reports and trend reports for standards are useful for management of the lab. Correlation of lab results to anneal cycle and other process information help quality and production personnel to identify problems before material is further processed or shipped to the customer.







CAPS™

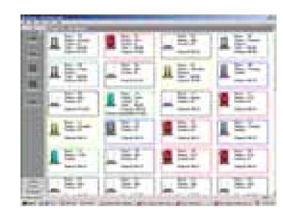
Annealing shops need dependable and timely control of all aspects of the process. CAPS™ provides the capability to integrate control of the various elements of the process into one seamless package consisting of inventory management, alarm recognition, process trending, base operation, data archiving, and reporting. CAPS™ provides access to many optional modules including Entec's thermodynamic models.

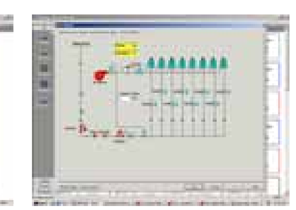
CAPS™ is specifically designed for the needs and requirements of the annealing operation. It can be utilized in a single stack or multi-stack shop using any atmospheric gas for **sheet, wire, and non-ferrous** products. The system provides tools to automate many of the routine functions performed in the annealing operation. CAPS™ is a valuable tool for new shop start-ups or can be easily retrofitted into existing shop configurations.

Supervisory Control System

CAPS™ is a Supervisory Control System for the complete anneal shop. The **Shop Overview** screen displays the current shop status, including critical information such as status, control temperature, and event time for each base.

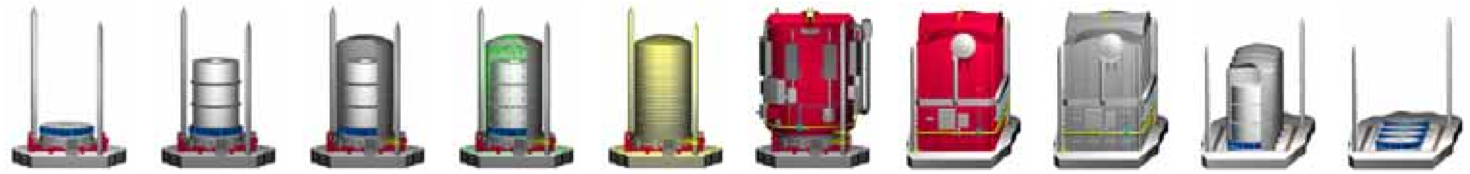
Specific base information is viewed and updated through the **Base Update** screen. Data is entered into screens using pull down menus and check boxes. Temperature **tables** and **graphs** for current and completed runs are viewed in CAPS™ to allow the process to be monitored efficiently and effectively. The operator is also notified of **alarm** conditions that require attention.





Human Machine Interface (H.60.SC)

CAPS™ with optional H.60.SC integrates Level 1 HMI functions for equipment control and operation to provide one seamless Level 1+2 package. This approach streamlines communications and provides a single user interface for all shop operations. The system is specifically designed to interface directly to PLC's operating 100% hydrogen anneal shops as well as nitrogen based systems. Screens for control of auxiliary equipment such as water systems, gas reducing stations, and hydraulic systems are also integrated into the interface.



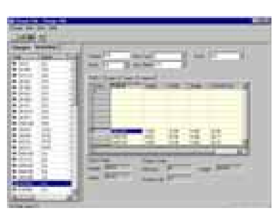
Inventory Management

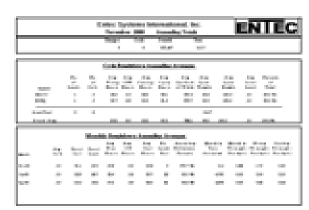
Connecting CAPS™ to the plant-wide Inventory Management System allows the operator to view and edit coils available to anneal. Scheduling information, such as priority, ship week, or anneal late start date, can be downloaded for use in building loads. This information can be used manually or by the Stacking Model option (when included). CAPS™ has the ability to interface with most Enterprise Resource Planning (ERP) packages.

Charge data is uploaded to the Inventory Management System when a load is assigned to a base. This data includes the estimated completion time of the load. Additional information is uploaded when the base has completed other important milestones.

Recipe Management

CAPS™ allows designated operators, or metallurgists, to enter cycles, or recipes, into the system. **Multiple steps** with different temperatures, gas flow rates, ramp rates, and hold times can be entered for each cycle. The operator chooses the cycle to run for each load, dependent upon the coils in the load. **Level 1 communication** provides automatic download of setpoints to the PLC or controller at the beginning and during the cycle.





Shop Management Reports

Shop management reports depicting the overall performance of the shop and equipment are included as part of the system. **Summary information** about shop operations such as tons produced, product mix, average load weight, re-anneal rate and other information is available for a specified period. In addition, **equipment utilization** reports showing heating tons per hour, cooling tons per hour, delay rate, and other items are provided. Process data is **archived** for use in CAPS™ standard management and history reports as well as ad-hoc reporting.

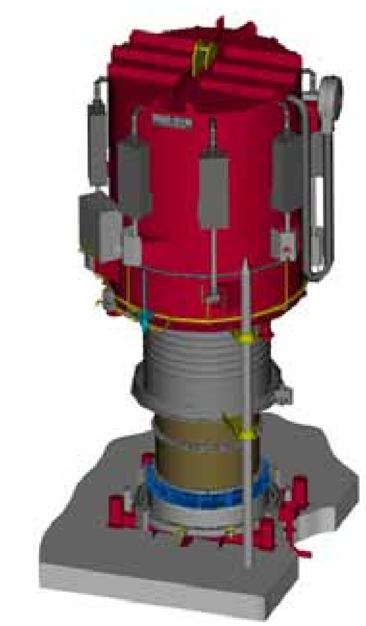
SHOP OPTIMIZATION MODEL

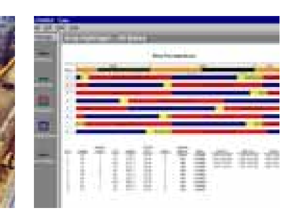
Entec's **Shop Optimization Model** utilizes a Global Planning Module and a Shop Planning Module to maximize throughput. This provides a complete system for optimizing throughput and operating costs.

Resource management within an anneal shop has a large impact on the throughput capacity of the operation. Shop managers must make daily operational decisions, such as, which coils to load and what equipment to schedule for maintenance. Efficient resource management assures that these decisions consider the effect on the long-term objectives of the shop and the total operation.

Global Planning Module

The Global Planning Module maximizes throughput by providing a comprehensive equipment utilization strategy for the shop using **Theory of Constraints** methodology. The optimization routine considers upstream "supplier" capabilities, downstream "customer" requirements, shop information, and data from the **Budgeting Application**. Output from the Global Planning Module includes information on the constraint resource, equipment utilization, and loading strategy for the Shop Planning Module.





Shop Planning Module

The Shop Planning Module uses the information provided by the Global Planning Module to make operating decisions. This module schedules specific charges and equipment for the shop. Charges are built out into the future and coil load and unload times are estimated for the inventory. The optimization routine maximizes throughput by exploiting the constraint resource of the anneal shop, as identified by the Global Planning Module. For example, if a shop constraint is the furnace, then the optimization routine will manage all other resources to prevent any furnace delays.

CLEANLINESS MODEL

The **Entec Cleanliness Model** uses the hot spot and cold spot data that are dynamically calculated by the Heating Model to control processing of each run. The gas stream setpoint is controlled to maintain a hot spot temperature below the "cracking" temperature of the oil. The base is held at the hot spot temperature until the cold spot for that step is reached, indicating that all the oil has been properly evolved.

The rolling oils used in a cold reduction mill are designed to burn-off during the anneal process. However, rolling oils have some physical limitations that require proper heating in order to alleviate surface cleanliness problems. In most shops, the initial heating rate is reduced to provide enough time for the oil to evolve. This is often accomplished by the use of ramps or steps in the heating phase.

The objective of these practices is to allow all of the rolling oil to volatilize from the surface of the sheet before raising the temperature above the "cracking" temperature of the oil. Most shops use a given practice within the entire shop, regardless of coil weight, coil gauge, load size, or other factors. This practice works, but does not optimize the process.

Is Your Shop Like This?

Have you had surface cleanliness problems that improved by adding shelf time and/or atmosphere gas flow? Now your throughput has decreased and your operating expenses have increased.

Most shops use a standard step duration (or ramp rate) and atmosphere flow rate for surface cleanliness critical material. Just as with the heating time look-up table, these methods assume uniform coils, stacking configurations, and operating conditions. Since the trial-and-error solution does not take into consideration product and process variations, the standard practice must be set-up as a "worst-case scenario" for all products. In other words, to get acceptable surface cleanliness from <u>all</u> charges, the standard cycle must set-up so that <u>most</u> charges are extended longer and use more atmosphere gas than necessary. These practices have a negative impact on **throughput** and **operating costs.**

STICKER BREAK MODEL

Sticker Breaks

" As the name implies, these defects result from the sticking of adjacent wraps of the coil during annealing. They are characterized by transverse, slightly crescent-shaped markings."

- "Cold Rolling of Steel" William L. Roberts

The **Entec Sticker Break Model** uses the thermodynamic model engine to provide a profile of temperature gradients during the cycle. This thermodynamic information is necessary to determine the best control strategy. Typical parameters, such as base fan speed, cooler fan speed, bypass cooling rate, and spray water initiation, are controlled in order to maintain an acceptable temperature gradient.

Sticker breaks are characterized by localized welding of two strip surfaces within a strip coil, leaving a crescent shaped surface defect. The breaks may be caused by a number of factors such as strip profile, winding tension, surface roughness, or annealing practices.

Although all of the causes are not anneal related, modified operation of the anneal equipment can reduce the occurrence of breaks from other factors. The major annealing related cause is excessive radial stresses caused by thermal variation within the coils. This is especially critical during cooling when the core of the coil remains hot while the atmosphere gas temperature is cooled.

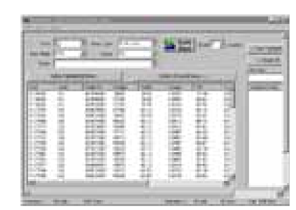
STACKING MODEL

Determining the "best" coils to be annealed in a particular load is a complex and time-consuming task for annealing operators. A substantial amount of training and experience is required in order to create the most favorable load from the various possible combinations of product dimensions, metallurgical and customer requirements, delivery needs, and shop constraints. Process computers are well suited for this task. In an optimal load, all of the coils reach their respective cold spot requirements at the same time. This **minimizes heating time** while providing maximum **mechanical property consistency**. At the same time, the stacking height must be maximized, delivery dates met, and hot spots limited.

Selecting Coils

Entec's **Stacking Model** simplifies the task of load building by allowing the customer to specify multiple stacking criteria, which are incorporated into the load building decision algorithm. Typical criteria include maximum coil overhang, allowable **cycle mixing**, and specific equipment or practices for particular products. The operators can also sub-divide the inventory depending upon the current shop conditions. The operator is allowed to enter specific **cycles, due dates, order numbers, or coil numbers** to subset the available inventory for the Stacking Model.

The Entec Query Builder function allows the user to develop custom queries to be used by the Stacking Model. The use of standard SQL protocol allows most shops to develop custom queries without specialized training.



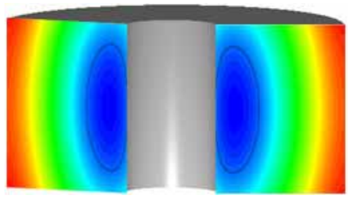
Thermal Resistant Factor (TRF)

TRF quantifies the amount of effort required to change the temperature of a given coil. TRF is a function of the physical characteristics of the coil and the cycle requirements.

Optimizing the Charge

The Entec Stacking Model uses an optimization routine to minimize the heating time difference (delta TRF) between the coils in the load. It also maximizes stacking height, and expedites the most critical coils without violating the shop rules. Stack weights are balanced for multi-stack bases to minimize burner trimming.

GRADE MIXING: The use of the Stacking and Heating Models toghether make it possible to **mix coils of different cycles** within one charge. The Stacking Model arranges the coils into the proper positions and the heating model calculates the charge setpoints and time to meet the require-ments of each coil.



HEATING MODEL

The **Entec Heating Model** utilizes the **thermodynamics** of the annealing process to determine each coil's interior temperatures. Radiation, conduction, convection, and other components of the process are all modeled for the specific equipment and product in the shop. The **hot spot** and **cold spot** temperatures of each coil are used to make control decisions. Accurate interior coil temperatures from real-time data allow Entec to offer features that **Decrease Operating Costs**, **Increase Productivity**, and **Reduce Mechanical Property Variation**.

The use of **Level 1 communications** provides real-time data to the model engine. The model revises its prediction periodically during the process to dynamically respond to process variation and events.

How Does the Heating Model Save Money?

Because every coil of every charge is analyzed, a closer estimate of the required annealing time is provided. When the model determines that the last coil has met the required annealing temperature, the furnace is automatically shut off. This use of the predicted interior temperature produces shorter cycles over traditional soak-type recipes. Shorter cycles mean less furnace fuel is burned—the largest utility cost in a batch anneal shop. Also, less electricity and less atmosphere gas is used as well. The additional productivity can also replace the need for additional annealing equipment.

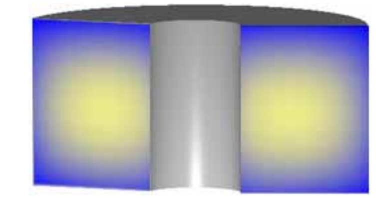
Heating Model Accounts For:

- Coil Properties:
  - -Weight
  - -Width
  - -Outside Diameter
  - -Inside Diameter
  - -Gauge
  - -Material Type
- Heating Method
- Atmosphere Composition
- Convection System Type
- Variable Flow Systems
- Control TC Performance

Is Your Shop Like This?

Annealing Shops process a variety of products with various dimensions and physical characteristics to satisfy numerous metallurgical and customer requirements. This task represents a significant challenge to even the most accomplished production team.

Most shops use a statistical method like look-up tables or regression analysis to determine heating times. These methods assume uniform coils, stacking configurations, and operating conditions. The potential for error is largest when the process is changed and when the product is at the extreme limits of the analysis. The "know-how" to meet the challenge of exceptional non-recurring events often resides with one experienced operator. These practices may have a negative impact on **consistency** of product quality and process operating costs.

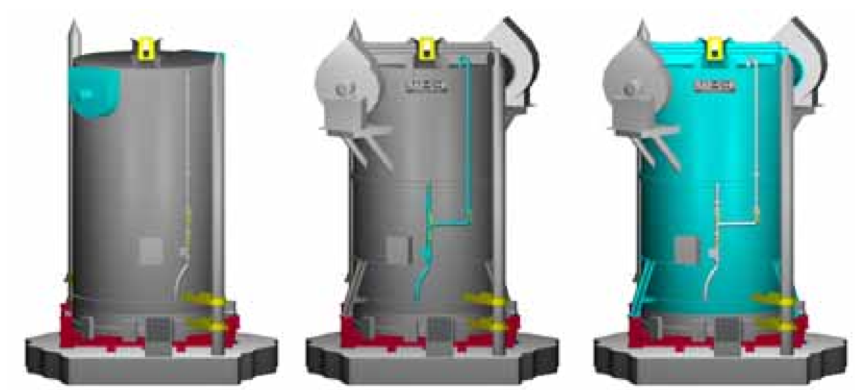


COOLING MODEL

The **Entec Cooling Model** also utilizes the thermodynamics of the annealing process to determine coil's interior temperature. The cooling phase of the annealing process is often overlooked when considering opportunities to improve the operation. But, many of the benefits gained by optimizing load building and heating can be lost by overextending (or cutting short) the cooling phase. Automation of the cooling process provides opportunities to improve **quality** and **scheduling** as well as **reduce electricity** usage.

Scheduling and Throughput

Improved plant and shop scheduling are important contributing factors in optimizing product throughput and equipment utilization. Scheduling algorithms require input of critical data such as hours-to-process and expected completion time. Automation of the cooling process provides accurate and timely estimates of these values in order to provide more precise shop and base scheduling, resulting in more efficient delivery predictions. Unpacking the annealing base as soon as the cooling phase has been completed can greatly increase shop throughput while having no negative impact on quality.



Is Your Shop Like This?

Traditional shops use the gas stream, base, or touch thermocouple to determine when a base is ready to unload. In some cases the "unload" temperature is varied based on load size or time of year.

This traditional method assumes that one thermocouple reading accounts for the charge variations and dynamic operating conditions affecting cooling.

First, the operator must be in a position to actively monitor the thermocouple temperatures in order to take action when the unload temperatures have been attained.

Second, it is not definitely known that all coils in the charge have actually attained the proper critical temperature to unload the base. This often results in overly conservative split temperatures in order to assure that it is "safe" to unload the base. This practice can result in idle furnaces, underutilized bases, increased energy costs, and reduced throughput.