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I/A Series[®] Software RBATCH II





The I/A Series RBATCH II package automates batch production control activities in a plant and provides an integrated environment for recipe management, process management, unit supervision and production information management. The automation of a batch plant can provide significant advantages, such as:

- Faster batch processing resulting in greater production capability.
- More consistent product that meets tighter tolerances.

- Flexibility of manufacturing different products and grades of products and quick switch over between products.
- Extensive data collection and reporting, associated with batch production that helps in production tuning and meeting FDA requirements.



OVERVIEW

A simple batch process may be controlled by using only control blocks and ladder logic, where one or more sequence blocks may be used for the scheduling and coordination of sequential control, continuous control, and interlock functions. However, many batch applications require recipes for the manufacturing of different products or different grades of the same product. Also, lot tracking and the generation of batch reports are required for most batch control applications. In those cases, the RBATCH II package may be used for the supervisory control functions.

RBATCH II is an easy-to-use graphical control package that does not require any programming. The configuration process requires specifying the recipes after creating a process model. Recipes are represented graphically in Sequential Function Chart format. They are configured interactively on workstation display screens with icons and selections from pull-down menus. The process model is created by specifying unit and phase data on interactive screens.

Functions

RBATCH II is a fully configurable graphical software package providing the equipment independent interface in batch production processes. The major functions are:

- Providing the environment for creating a process model.
- Providing the environment for the configuration and maintenance of a library of Master recipes.
- Creating control recipes when new batches are specified and scaling the ingredient quantities per specified batch sizes.
- Creating master recipes from control recipes with the option to retain unit selections.
- Downloading formula variables and specifying the orderly execution of phases during a batch production cycle.
- Providing a set of intuitive and graphical human interface screens for the execution of batches along with the capabilities of adding additional application dependent interfaces.

- Allowing multiple batches running concurrently.
- Allowing priority based execution of batches, where the priorities may be manually specified or modified.
- Providing batch tracking and reporting functions.

An RBATCH II recipe is equipment independent, allowing the same recipe to be used for the production of batches in similar but different sets of units (process cells). The actual units may be selected at the start or during the execution of a batch. A recipe consists of a set of phases (e.g., FILL, HEAT, STABILIZE, COOL, DISCHARGE etc.) and unit operations, which are a collection of phases, and a set of formula variables (e.g., quantity, set point, waiting time etc.).

The human interface provides a batch-oriented view of the plant. It allows the selection of a recipe, changing the batch size, and starting a batch. It allows a batch to be run in AUTO, SEMI-AUTO, or MANUAL modes.

The batch tracking and reporting function allows the automatic storage of all significant events in a batch along with other application dependent data, as specified. A batch report may be generated at any time during or after a batch production.

The RBATCH II package provides standard human interfaces which consist of configuration and operator interfaces. Additional application specific interfaces, graphic or otherwise, may be built using standard I/A Series tools.

Benefits

Since RBATCH II is a graphically configurable package it can be setup and used by process engineers without the need of programming. This also makes the addition and modification of batch applications very easy. Operators can create batches, assign equipment, and run batches in automatic, semi-automatic, or manual modes. This allows the maximum flexibility in running the batches.

By splitting the logic into real time process control (the phases running in sequence blocks) and into supervisory control (RBATCH II), a Top-Down/ Bottom-Up approach can be followed, allowing a structured and efficient implementation of batch projects. The structure of RBATCH II is optimum for batch control projects and follows the recommendations of the various industry standards on batch control such as NAMUR and ISA/SP88 committees.

PACKAGE DESCRIPTION

The RBATCH II package includes functions necessary to configure a process model (units, phases, and phase parameters) and recipes associated with the production of batches (of product).

The phases associated with production such as FILL, HEAT, etc. are plant equipment dependent. By interfacing to these phases, the RBATCH II package can be configured to fit almost any kind of batch production plant.

An operator display allows the initiation of a batch production. The package then activates the appropriate phases in the sequence blocks after down loading formula variables held in recipe files (Figure 1).



Figure 1. RBATCH II Structure

The main functions of the RBATCH II package are:

- Recipe Management
- Process Management and Unit Supervision
- Production Information Management

The Recipe Management function provides the environment for the specification of the process model and the configuration of master recipes. The Process Management and Unit Supervision functions allow the creation of batches and control recipes and their orderly execution along with the downloading of the formula variables. The Production Information Management function provides the capability of collecting event related data and generating batch reports.

Recipe Management

The recipe management function provides the environment for the process engineers to configure, copy, and modify the Process Model and the Master recipes in an interactive mode.

Process Model

A process model consists of a unit table and phase database. A unit table is created by specifying the units and unit types (Figure 2) on interactive screens. Units that can manufacture similar products are considered to be of the same type. Thus, similar reactors may be grouped together as a single unit type. The phase database consists of phase names and formula variables. The phase names along with their applicable unit types are specified via an interactive screen (Figure 3). Multiple phases with the same name may be specified for different unit types, e.g., Initialize for reactor and Initialize for charging tank. Once a phase is specified the names of the formula variables and their default values may be entered (Figure 4). A formula variable can be a real, integer, boolean or string. For numerical values the upper and lower limits may be specified.

Master Recipe

A Master recipe specifies the order of execution of Phases and Unit Operations (Figure 5) along with a set of commands like: Select_Unit, Book_Unit, Release_Unit. Unit Operations are convenient groupings of phases. Both unit operations and phases are configured in the graphical Sequential Function Chart (SFC) format. The unit operation names are specified at the time of their configuration and phases are selected from a pop up library. Parallel or alternate execution of phases along with the looping or skipping of one or more phases based on the specified process or other conditions are allowed in a recipe.

		Unit Editor		
File				Help
Unit Name	Unit Type	SYMBOL	~	
FEED_TNK	FEED_TANK		Unit Name:	FEED TNKA
FEED_TNKA	FEED_TANK			
RCP_REACT_A	REACTOR	*	Unit Type:	FEED TANK
RCP_REACT_B	REACTOR	*		
RCP_REACT_C	REACTOR	*	Symbolic	
REACTOR_M1	REACTOR			
REACTOR_M2	REACTOR			
REACTOR_M3	REACTOR		2	
Add		Change		Delete

Figure 2. Unit Table



Figure 3. Phase Configurator



Figure 4. Phase Parameter Configurator



Figure 5. Recipe Configurator

Process Management and Unit Supervision

To make a batch, the operator enters a batch name, selects a recipe from the library, and enters the quantity to be produced (Figure 6). The process management function then creates a Control Recipe from the selected Master Recipe and waits for the START BATCH command. The START BATCH command which may be given from the Batch Overview Display (Figure 7) or from a Batch Display (Figure 8) starts the batch. The Batch Overview Display shows all the batches that have been created and have not ended. A number of batches may be created in one session and also a number of concurrent batches may be active at the same time. A Batch Display is the detailed display of a batch where the status of phases and unit operations are shown in the sequential function chart format. The formula variables associated with a phase may be displayed and modified by an operator (Figure 9). The operator may modify a selected variable within its specified limits; a pop-up window displays those limits. A batch may be executed in either of the three modes: AUTO, SEMI-AUTO, and MANUAL. An operator may select any one of the modes at the start of a batch and can switch the mode during the execution of the batch. AUTO mode, which is the default mode, automatically activates the unit operations and phases as specified in a recipe. In SEMI-AUTO mode, the operator must CONFIRM, or SKIP the start of each phase. (The order of phases is specified in a recipe.) In MANUAL mode, the operator can randomly select any available phase in the recipe to be performed next. This allows a failed phase to be retried or allows the dumping of the batch, e.g., by going straight to a DISCHARGE phase.

		Graphical Human Interface			
		Create Batch Display			
Created Batches	Recipes			Batch:	
				Recipe: [
			Q	uantity: [
				Limits	
				Create	Assign
			L	Batch	Recipe
				Print Report	Print Recipe
	-				
Aessage:			ACK		

Figure 6. Create Batch Display

5		Graphica	l Human Interface			
Batch Overview Display TE						TEST1
Batch	Recipe	Quantity	Mode	Status	Start	End
tc_5 Screen Cap	sfc_series sfc_parallel	100.00 % 100.00 *	automatic automatic	active	Batch SemiAuto Mode Automatic Mode	Batch Manual Mode
					Тор	
					Store Recipe	Deassign Recipe
				-		
Message:				ACK		
Exit	Unit Overview	Batch Display	Create Batch			

Figure 7. Batch Overview Display

	Batch Display		TE
Unit Operations	Phases	Batch:	Screen_Cap
sic parallel		Recipe:	sfc_paralle
		Quantity:	100 %
		Mode:	automatic
		Status	inactive
OPERATION1 OPERATION2		Start Batch	End Batch
		SemiAut Mode	o Manual Mode
End		Automat Mode	ic Retry
		Select Unit	DeSelect Unit
		Select Path	
		Start Phase	Stop Phase
essage: I	AC	Skip Phase	Store Recipe
Evit Unit Batch	Create	ormula Unit	Phase

Figure 8. Batch Display

Formula Display						
ariable	Value	Eng Units	Batch:			
			Recipe			
			Quantity: 0			
			Label:			
			Phase: [
\$sage:		ACK				



The unit supervision function manages unit resources and collects batch and unit-related data for recording. The unit resources are maintained by the booking and releasing mechanisms for each unit. This allows multiple batches to be produced on different units without the fear of contamination of those batches. The Unit Overview Display (Figure 10) shows the units and their booking status.

Creation of Master Recipes from Control Recipes

A master recipe can be created from a control recipe. A new master recipe name has to be specified and there are options for specifying the desired quantity (batch size) and retaining the unit selections.

Production Information Management

A complete batch tracking, reporting function is included in the RBATCH II package. All actions taken during the production of a batch are time stamped and stored in a special report file. The file is unique for each batch and remains archived and available for reporting until a user actually erases it from the bulk storage, presumably after saving it on a removable medium (floppy disk). A batch report (Figure 11) may be scheduled or generated on operator request. The following standard information is stored in the report file:

- batch name
- batch size
- recipe name used
- date and time of batch creation and completion
- the selection, booking, and releasing of units
- the start of each phase, including the parameter values used
- batch mode changes by the operator
- · parameter changes by the operator

Additional application dependent data collected by sequence blocks may be stored in a batch record. The resulting report gives a comprehensive view of all events relating to a batch and can therefore be seen as a batch tracking report.

Unit Booked By Batch Unit Booked By Batch Unit Unit Unit Unit Unit Unit Out Available of Service Message: Message: ACK	ري. ل		Craphical RE	atch Human Interface				
Unit Booked By Batch Unit Unit Unit Unit Unit Unit Unit Unit	Unit Overview Display							
Message:	Unit	Booked By	Batch			Book	Release	
Message:		2	-			Unit	Unit	
Message:						Unit	Unit Out	
Message:						Available		
Message:								
Message:								
Message:								
Message:								
Message:								
Message:								
Message:								
Message:								
Message: ACK								
Message:								
Message:								
Message:								
Message:				f				
	Message:				ACK			
Batch Batch Create Unit		B	tch Batch	Create	Г	Unit		
Exit Overview Display Batch Graphic	Exit	Ove	view Display	Batch		Graphic		

Figure 10. Unit Overview Display

B_00001 recip_01 100 KG				
	D01	CHANGE FORMULA	QUANTITY	25.0
	D01	CHANGE FORMULA	MAX_TIME	10.0
		START RECIPE	AUTŌ	
REACTOR_1		BOOK UNIT		
TANK_1		BOOK UNIT		
REACTOR_1	D01	START PHASE	DOS_1	
_		QUANTITY	25.000 TON	
		MIN_INCREM	25.000 TON_	HR
		MAX_TIME	10.000 HOUF	3
		:		
		:		
REACTOR_1	ST1	PHASE DONE STR	SUCC	ESSFUL
		RECIPE ENDED		
		BATCH COMPLETED		
	B_00001 recip_01 100 KG REACTOR_1 TANK_1 REACTOR_1 REACTOR_1	B_00001 recip_01 100 KG D01 D01 REACTOR_1 REACTOR_1 D01 REACTOR_1 ST1	B_00001 recip_01 100 KG D01 CHANGE FORMULA D01 CHANGE FORMULA START RECIPE BOOK UNIT BOOK UNIT BOOK UNIT REACTOR_1 D01 START PHASE QUANTITY MIN_INCREM MAX_TIME : : REACTOR_1 ST1 PHASE DONE STR RECIPE ENDED BATCH COMPLETED	B_00001 recip_01 100 KG D01 CHANGE FORMULA QUANTITY D01 CHANGE FORMULA MAX_TIME START RECIPE AUTO BOOK UNIT REACTOR_1 D01 START PHASE DOS_1 QUANTITY 25.000 TON MIN_INCREM 25.000 TON_ MAX_TIME 10.000 HOUR : : REACTOR_1 ST1 PHASE DONE STR RECIPE ENDED BATCH COMPLETED

Figure 11. Example of Batch Report

FLEXIBILITY AND OPENNESS

The RBATCH II package provides flexibility in the way the batches may be created and executed. Software commands may be used in place of operator commands to initiate the common operator functions, such as creating, starting, and ending batches; selecting units; changing the batch modes. Thus, a batch may be started automatically from a scheduler or when process conditions are right. If required, a campaign, consisting of a number of sequential batches, may be started by an operator, where the batches within that campaign may be started automatically.

SYSTEM CONFIGURATION

The RBATCH II package runs on an Application Workstation 51 (AW51) or Application Processor 51 (AP51). The RBATCH II graphical human interface requires a 50 Series Workstation Processor or Application Workstation (WP51, AW51, WP50, AW50). Additionally, X terminals hosted by 50 Series Workstation Processors or Application Workstations can be used to access the graphical human interface. A Personal Workstation (PW) or a WP20 or WP30 hosted by an AW51 or AP51 may be used as the operator interface to the tabular format rather than the graphical interface.

CONCLUSIONS

The I/A Series system provides comprehensive and scalable batch control capabilities. The RBATCH and RBATCH II packages provide the supervisory level batch control functions. The sequence control, continuous control and discrete (device) control along with process monitoring and exception handling are provided by control blocks in Control Processors (CPs). The safety interlocking functions providing the personnel and environmental protection can be configured as fast ladder logic in Fieldbus Modules (FBMs).

The RBATCH II package provides graphical user interfaces running under X-Windows and requires an AP/AW51 as host and 50 Series Workstations. For smaller applications, the RBATCH package having the tabular user interface is available. This package runs on a PW or an AP20, AW50, or AP50 hosting a WP20, WP30, or 50 Series workstation. Utilities allowing translation from tabular to graphical recipes and vice versa allow easy migration from RBATCH to RBATCH II to provide a scalable solution to batch control.

The Foxboro I/A Series software and hardware architecture gives you the flexibility and the power that you need to control your batch and sequential control process. The system is scalable and conforms to varying requirements both physically and functionally.

FUNCTIONAL SPECIFICATIONS

Process Model

MAXIMUM NUMBER OF PROCESS UNITS: 150

MAXIMUM NUMBER SEQUENCE BLOCKS THAT MAY BE ACCESSED DIRECTLY:

```
1000
```

MAXIMUM NUMBER OF FORMULA VARIABLES PER PHASE, WHEN DOWN LOADING TO ONE SEQUENCE BLOCK

24 booleans, 8 integers, 15 reals and 10 strings [Note: These limitations do not apply when down loading to multiple blocks.]

Recipe

MAXIMUM NUMBER OF RECIPES

The only limitation is the hard disk space in the host processor (AP or AW).

MAXIMUM NUMBER OF STEPS (PHASES AND COMMANDS) IN A RECIPE:

250

MAXIMUM NUMBER OF PHASES OR UNIT OPERATIONS FOR OPERATOR SELECTION OR PARALLEL EXECUTION:

[Note: Unlimited number of parallel phases or unit operations are possible through nesting.]

Batches

MAXIMUM NUMBER OF CONCURRENT BATCHES: 100

¹²

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