



JAI Congres 2010, VIGO

Batch Process Control with PLC Industrial and Lab Applications

November 18th, 2010

Vigo, JAI Congres 2010

University of Applied Science
Department of Electrical Engineering
Goebenstr. 40
D-66117 Saarbrücken

Curriculum Vitae

Data:

Name: Benedikt Faupel



Education:

1981-1987

Study of Electrical Engineering at the University of Aachen / Qualification Graduate (Diploma)

1987-1992

Member of Laboratory of Machine Tools and Production Technology at the University of Aachen (WZL)

www.rwth-aachen.de

Qualification: PhD

Research Work: Expert systems / Technical Diagnosis



Curriculum Vitae – Industrial Carreer

1992-1997

SICOWA Process technology for building materials
Leader of department of Electrical, Control- and Automation Technology

1998-2002

Otto-Junker GmbH
Heat Treatment Technology
Leader Process Technology

www.otto-junker.de





Curriculum Vitae / Career as Professor

www.htw-saarland.de



HTW, University of Applied Science

- School of Engineering
- Group Electrical Engineering



Faupel

Education	Control Loop Technology, Process Automation / Simulation
Labs	Process Automation PLC Lab
Research	Automation with PLC Matlab/Simulink Application
Institute	Member of Institute for Physical Process Technology (IPP-HTW)





Relationship Uni Vigo & HTW



- Relationship founded / contracted in 2003
- 2005 Student excursion HTW students to Vigo
- Exchange of students (Vigo -> Saarbruecken)
- JAI Congress 2007
- Final Project in Automation (Nacho Armesto / Faupel)
 - 2007: Ruben Herrero Alvarez
A Lab-system for Controlling Servo-Engines with Profi-Net
 - 2009: Jose Manuel Barros Lopez
Design and Realization of a Lab-System based on Embedded Technology and OPC



Research Topic – Use of Simulation Tools

Matlab/Simulink

- Control Loop Technology
- Process Identification
- State control technology
- Digital Control Technology

LabVIEW

- Control of a Cooling System for Wind Power Systems



Research Topic – Automation with PLC

Training in PLC-Systems (Siemens)

- Modern Programmable Languages (S7-HiGraph, SL, CFC, SIMIT)
- Communication technology (ASi, ProfiNet Profibus-DP, Hart, Ethernet)
- Safety Concepts (ProfiSafe)
- Automation and Drive Control
- Process Control and Controller Design
- Visualization in WinCC & WinCC-flexible

Realized Industrial Projects

- Process Control „Heat-Treatment-Application“ (2007)
- Modellization of Burning Processes in Biomass Power Plant (2010)
- Automation of Lab-System for Auto-Fluid Processes (2010)
- PLC Training Courses for Industrial Partners (since 2005)



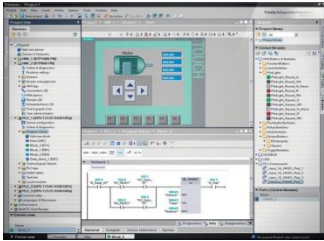
My Conference „Batch Process Control with PLC“

Contents

- Motivation
- Basic Concepts for Batch Processing on PLC
- Recipe Data Concept / PLC-Programm structure
- Applications for Lab and Industrial Use
- Application for Dosing/Mixing-Process on PCS7



Innovation for Automation



TIA Portal
Step 7 Basis for S7-1200



New Release Step 7
V5.5 (Shared I/Os)



New Controller Concept
PLC S7-1200 / HMI



Ethernet-Switch
communication



Embedded controller
PCS7-Box

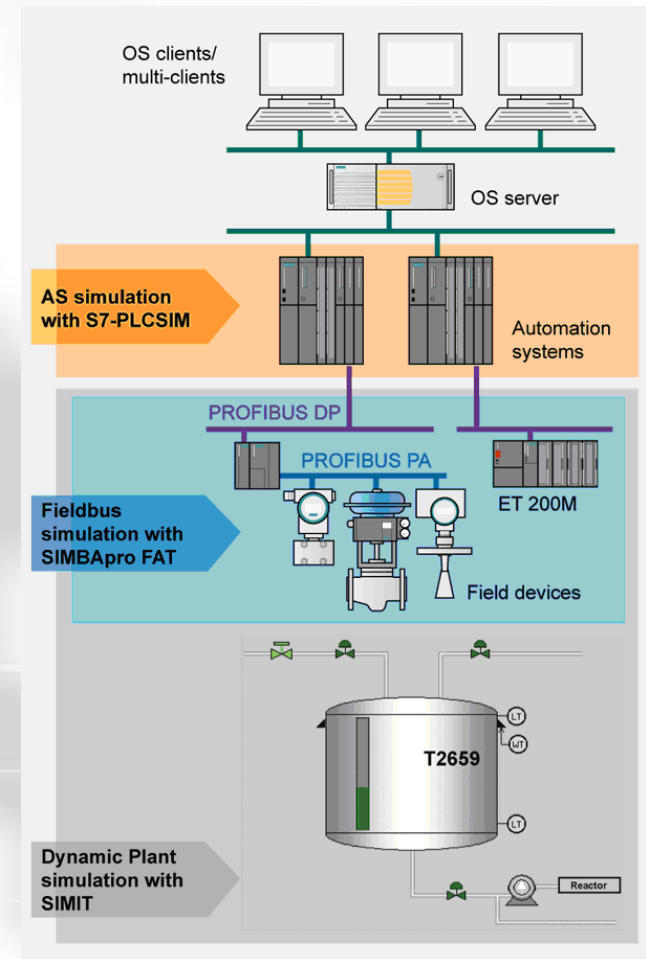


Simulation Tools
PCS7 / PLC for Batch
Control



Simulation Tools for Process Automation

- **Controller Simulator (PLCSim)** -Allows development and testing of configuration logic without controller hardware
- **SIMBApro** -For simulation of I/O signal response (conventional I/O and digital fieldbus) in order to test timing and system loading
- **SIMIT** – Modular software simulation package that can be used for pane checkout, loopback testing, to simulate mass flow (through pipes, tanks, pumps, valves and heat exchangers), batch / recipe development and operator training



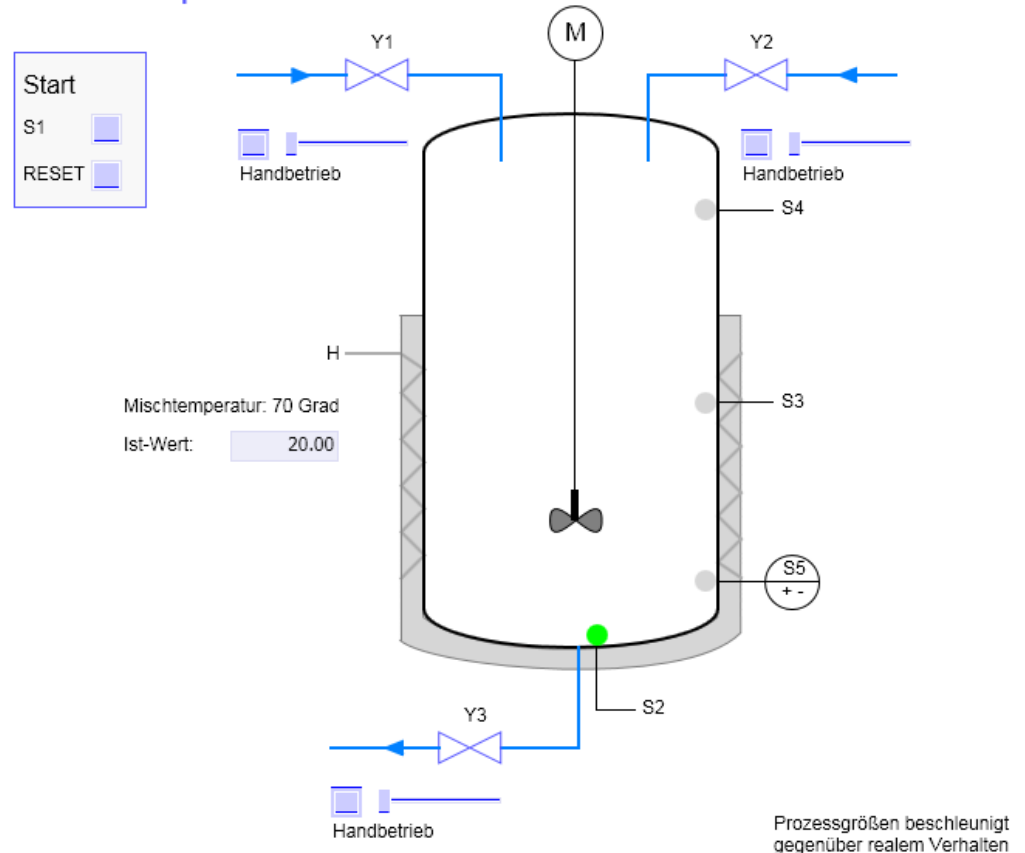


SIMIT Batch Application

Batch Process

- Filling Input Y1
Quantity Q1 / Unit [Kg]
- Filling Input Y2
Quantity Q2 / Unit [Kg]
- Heating on Temperature
Unit [°K]
- Mixing Time
Unit [sec.]
- Output Y3

Reaktionsprozess



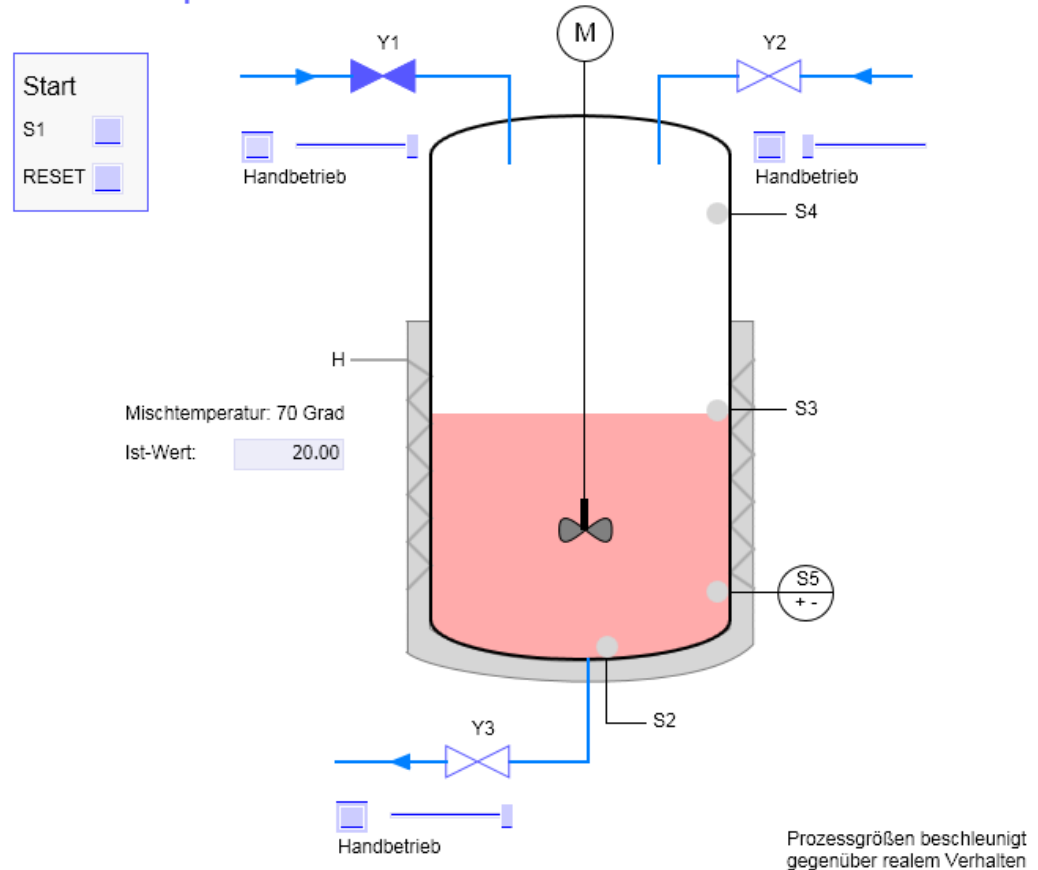


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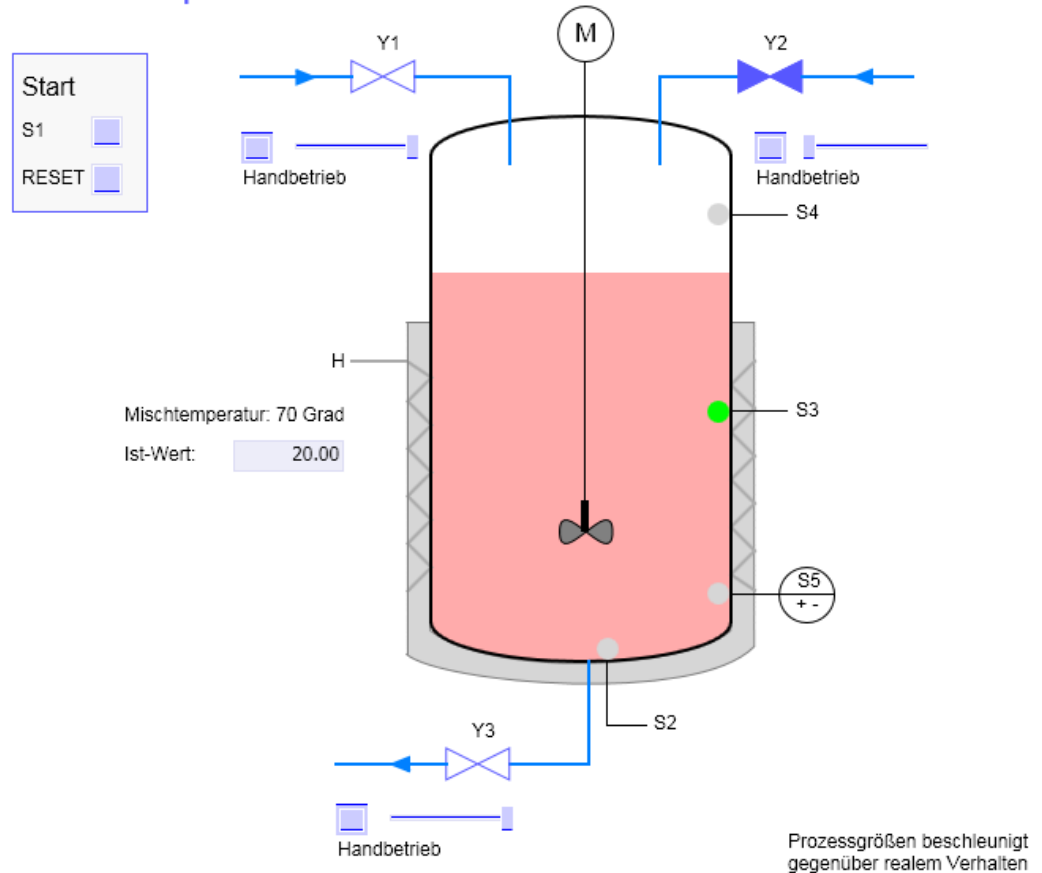


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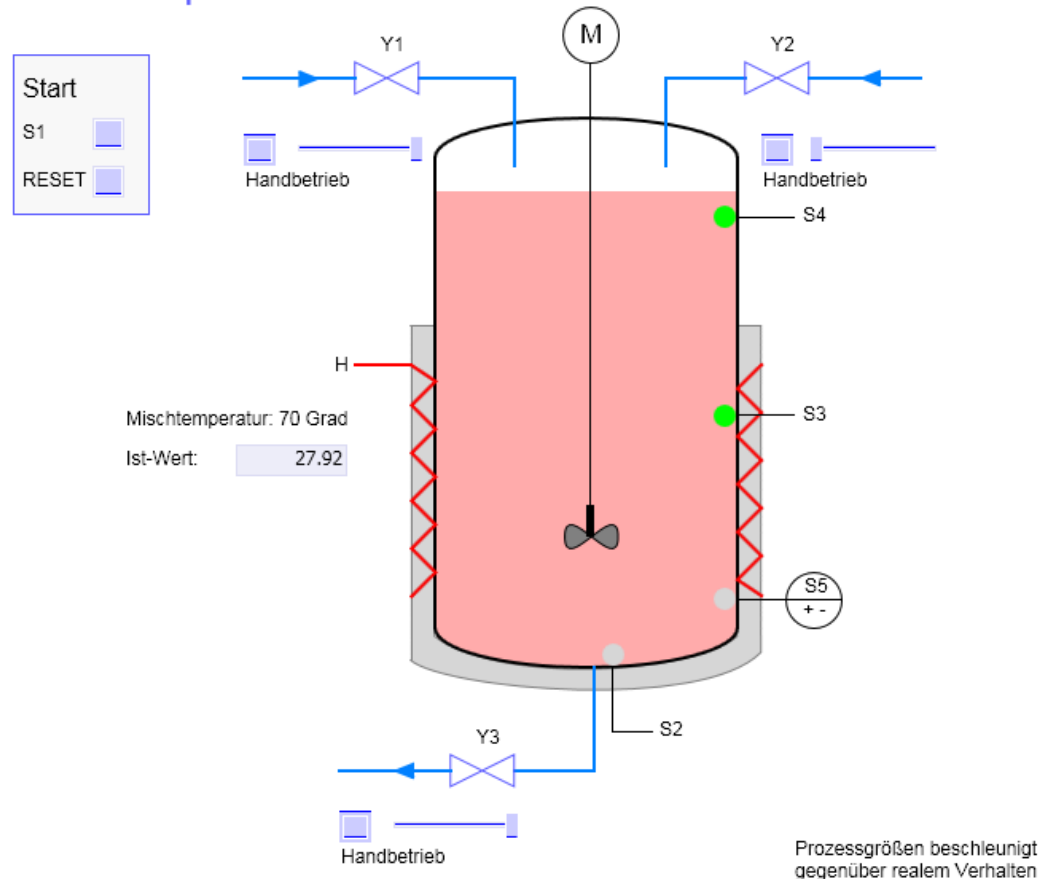


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Unit [sec.]
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Reaktionsprozess



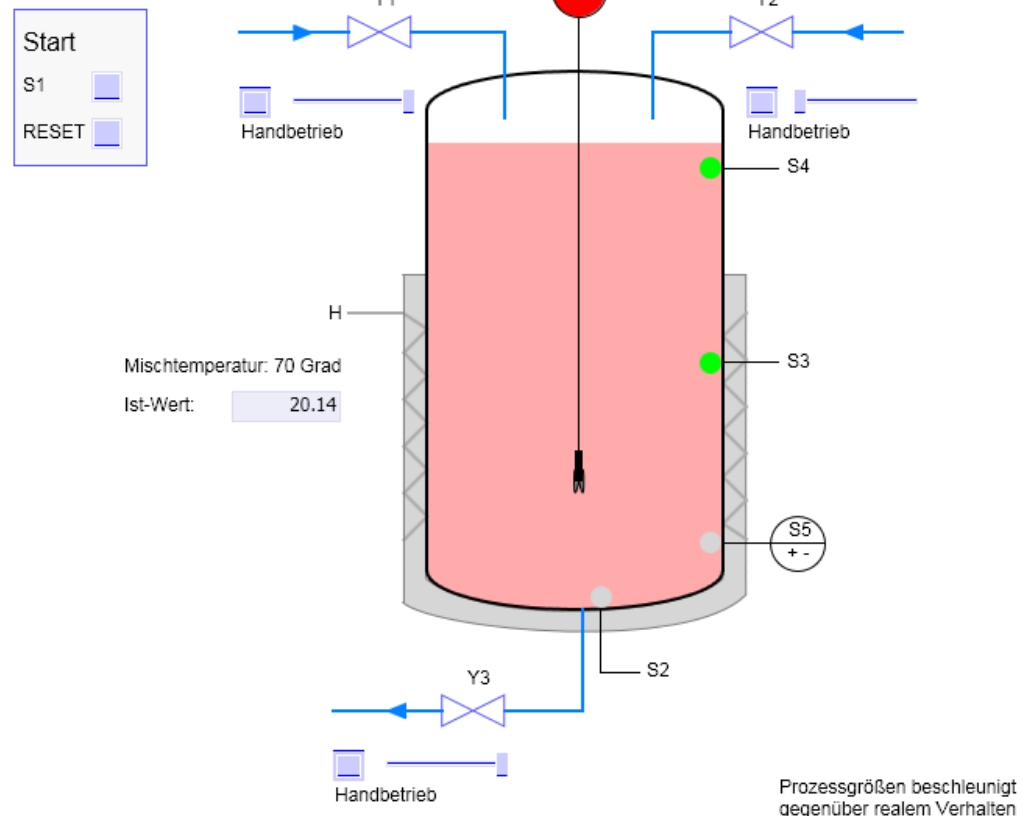


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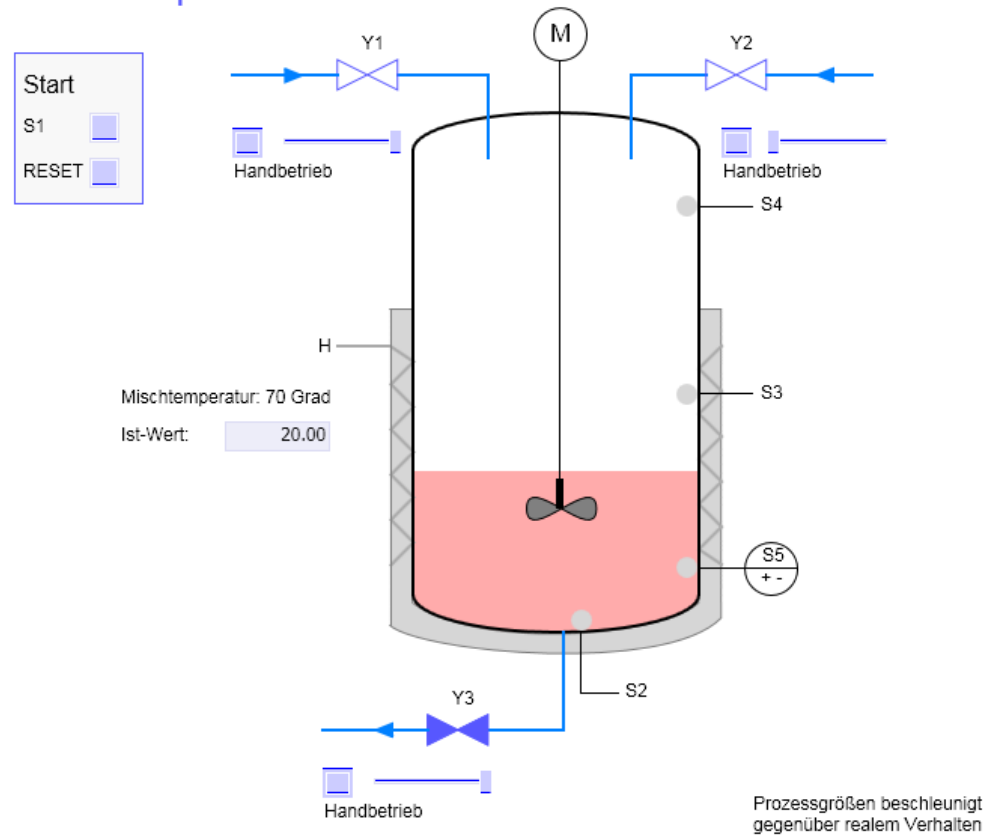


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Unit [°K]
- Mixing Time
Unit [sec.]
- **Output Y3**

Reaktionsprozess





Data Block Structure



Recipe /
Formula
Description

Adresse	Name	Typ	Anfangswert	Kommentar
0.0		STRUCT		
+0.0	DB_VAR	ARRAY[1..10]		vorläufige Platzhaltervariable
*0.0		STRUCT		
+0.0	Q1	INT	0	
+2.0	Q2	INT	0	
+4.0	Temp	REAL	0.000000e+000	
+8.0	ZEIT	TIME	T#0MS	
=12.0		END_STRUCT		
=120.0		END_STRUCT		

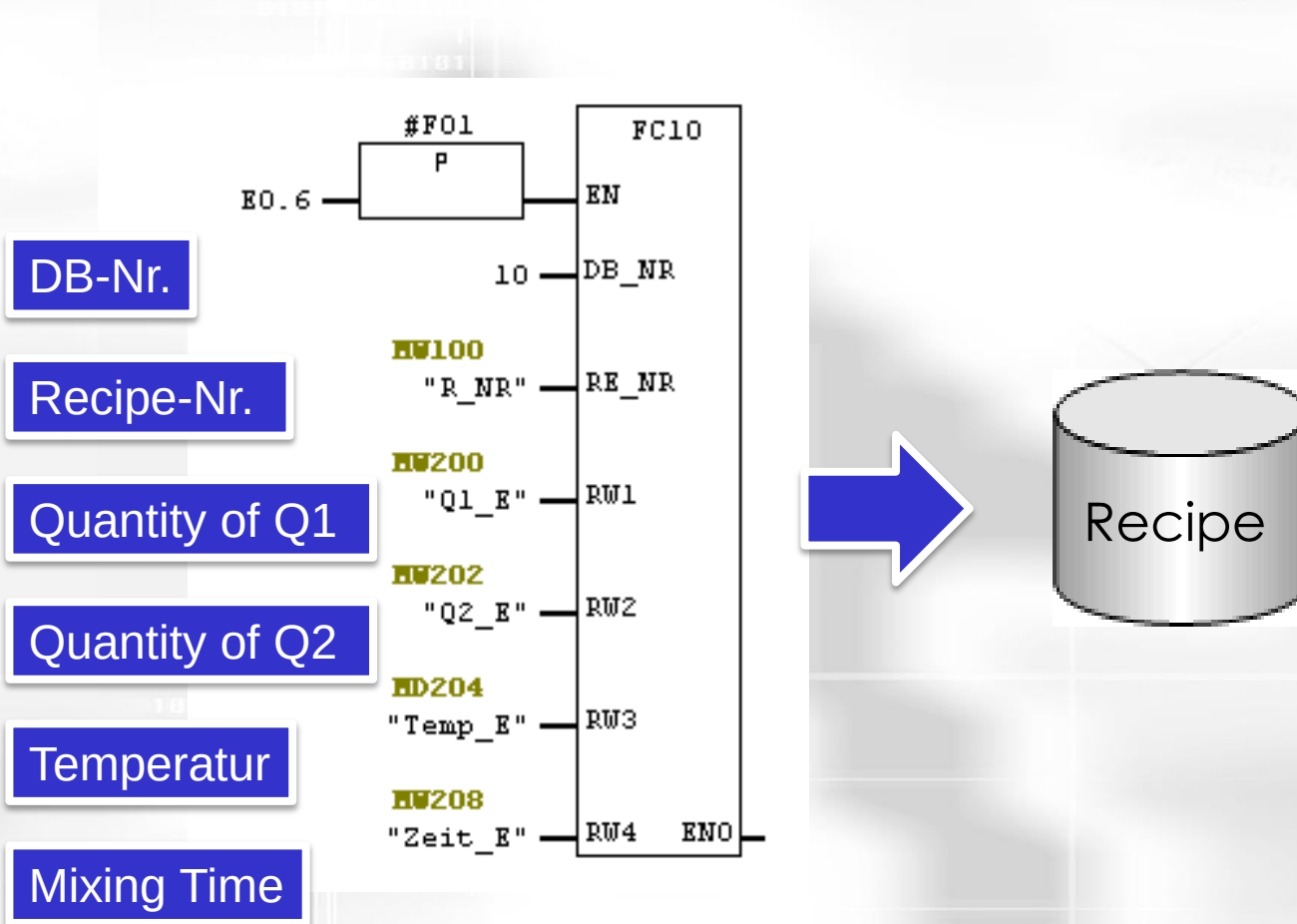
Total length of
Data Modell

Type Array of
Struct for 10
Recipes

Initial Values



FC Recipe Editor





FC Recipe Editor

DB-Nr.

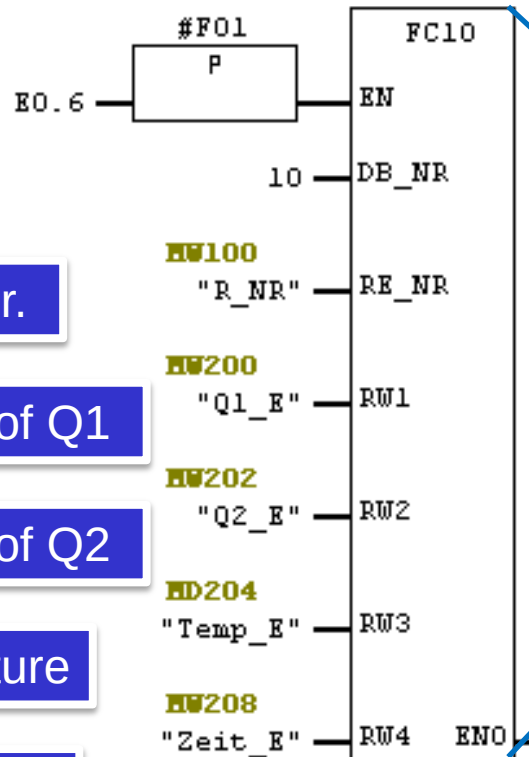
Recipe-Nr.

Quantity of Q1

Quantity of Q2

Temperature

Mixing Time

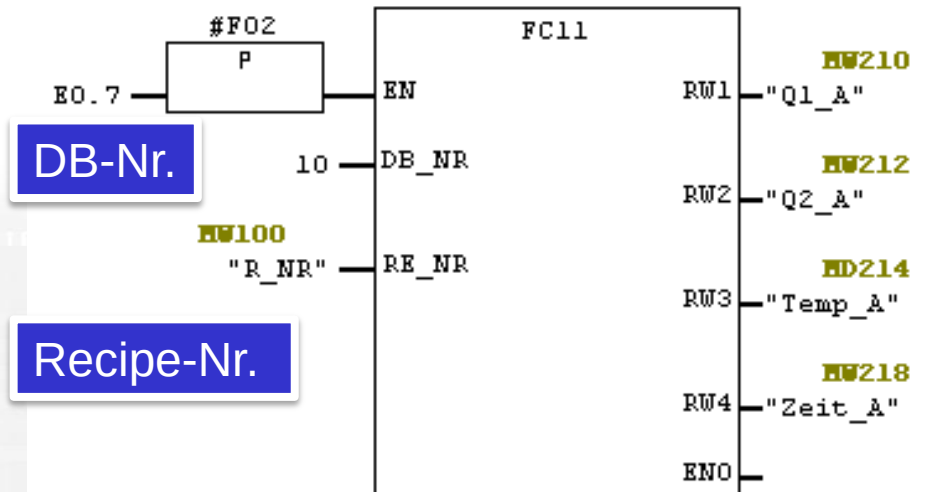


```

L    #DB_NR
T    #DBNRW
AUF  DB [#DBNRW]
L    #RE_NR
L    10
*I
SLW  3
LAR1
L    #RW1
T    DBW [AR1,P#0.0]
L    #RW2
T    DBW [AR1,P#2.0]
L    #RW3
T    DBD [AR1,P#4.0]
L    #RW4
T    DBW [AR1,P#8.0]
  
```



FC Recipe Reader



Quantity of Q1

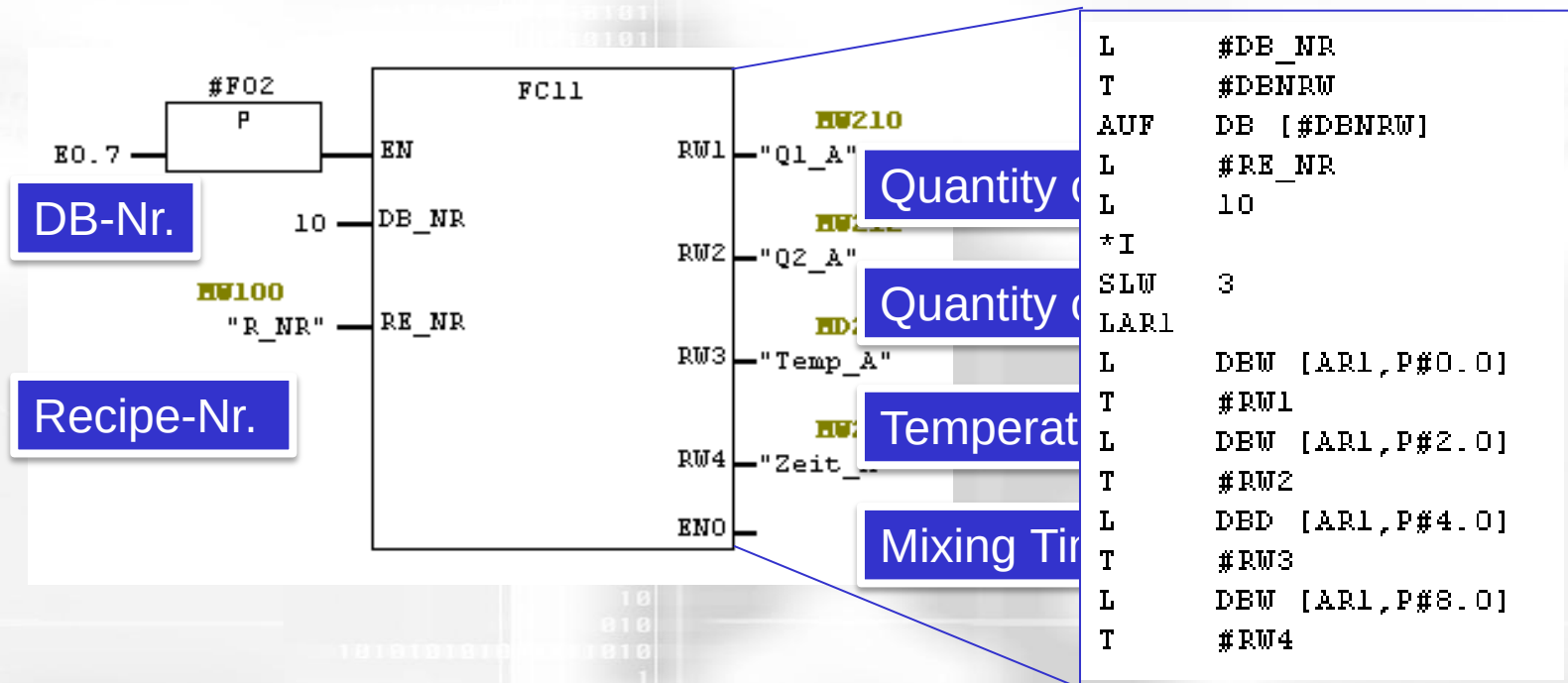
Quantity of Q2

Temperatur

Mixing Time



FC Recipe Reader

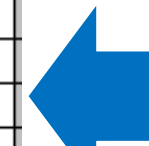




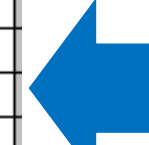
Recipe Data-Base



Adresse	Name	Anfangswert	Aktualwert
0.0	Q1_0	0	0
2.0	Q2_0	0	0
4.0	Temp_0	0.000000e+00	0.0
8.0	Zeit_0	S5T#0MS	S5T#0ms
10.0	Q1_1	0	10
12.0	Q2_1	0	20
14.0	Temp_1	0.000000e+00	30.0
18.0	Zeit_1	S5T#0MS	S5T#2m0ms
20.0	Q1_2	0	356
22.0	Q2_2	0	125
24.0	Temp_2	0.000000e+00	125.78
28.0	Zeit_2	S5T#0MS	S5T#20m0ms
30.0	Q1_3	0	1234
32.0	Q2_3	0	789
34.0	Temp_3	0.000000e+00	456.89
38.0	Zeit_3	S5T#0MS	S5T#2h
40.0	Q1_4	0	0
42.0	Q2_4	0	0
44.0	Temp_4	0.000000e+00	0.0
48.0	Zeit_4	S5T#0MS	S5T#0ms



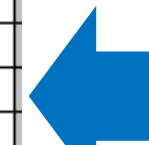
Recipe 1



Recipe 2



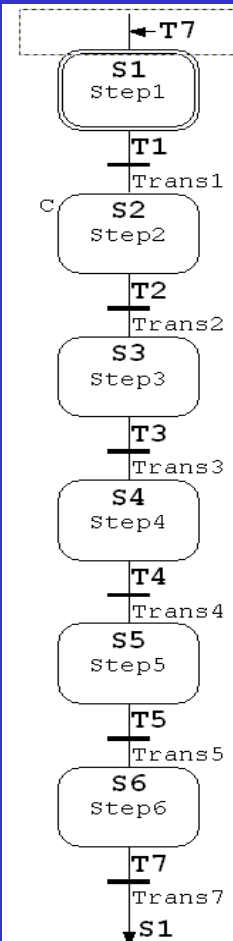
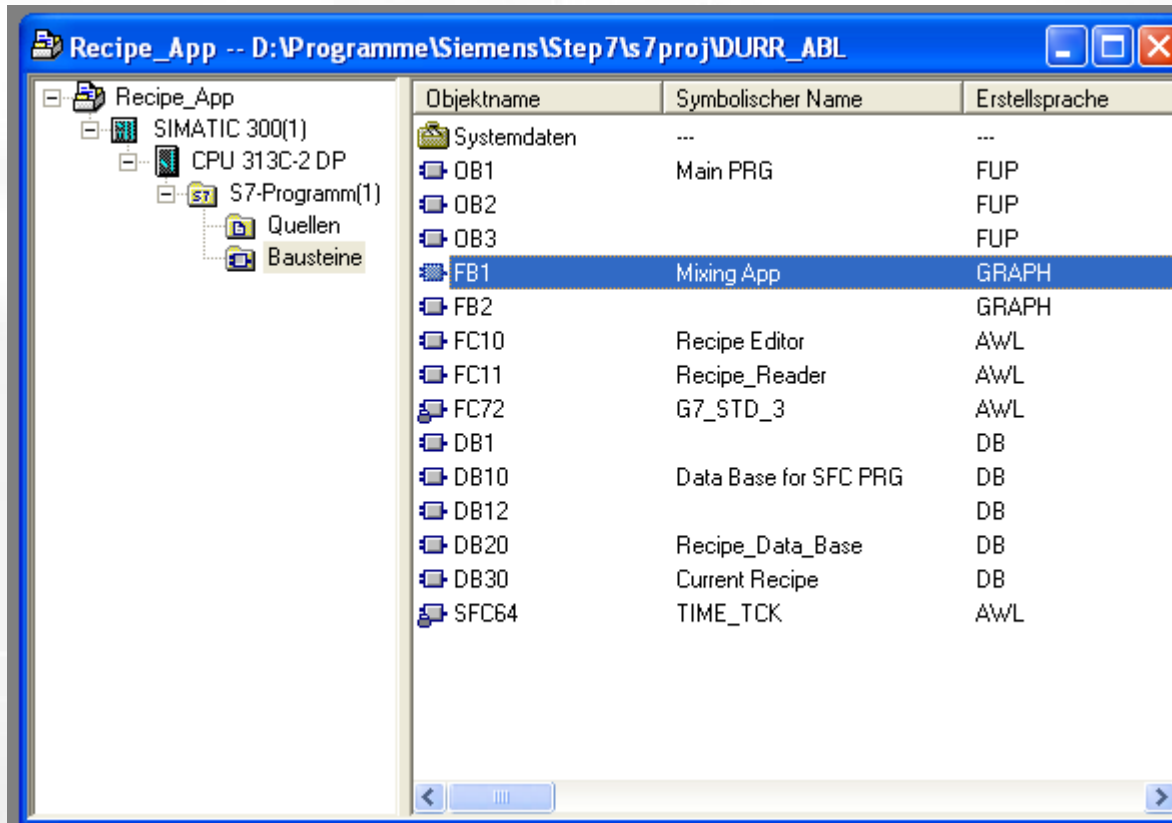
Recipe 3



Recipe 4



PLC – SFC-Program





PLC – SFC-Program

S1 Init Step

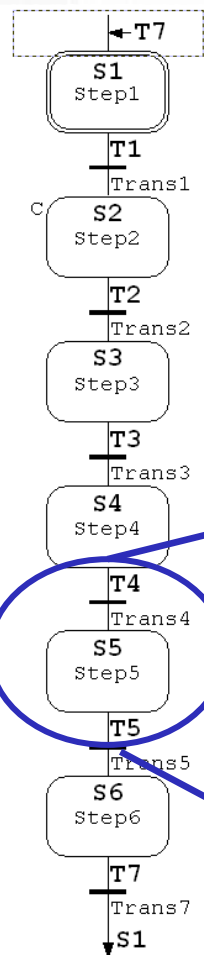
S2 Filling Y1

S3 Filling Y2

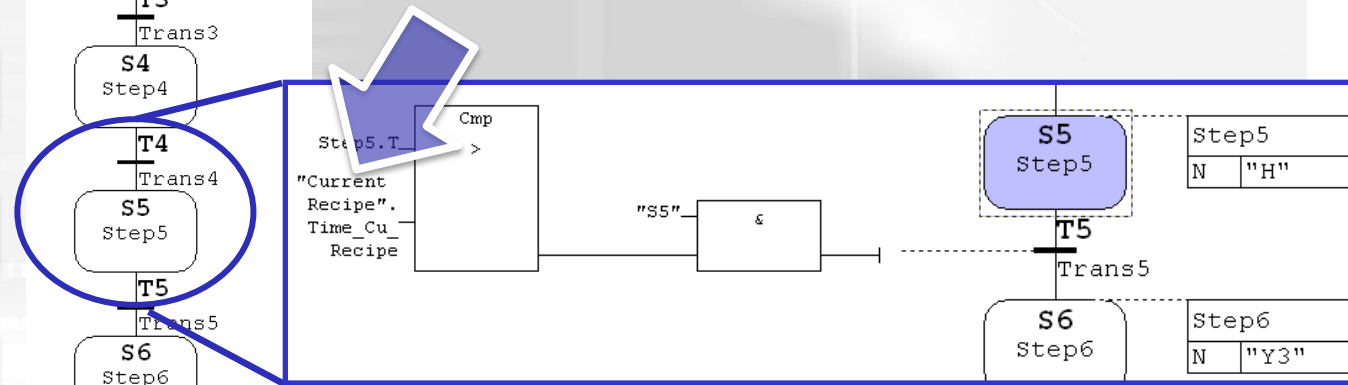
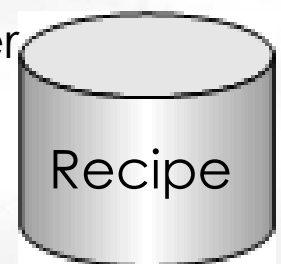
S4 Heating

S5 Mixing

S6 Emptying Y3

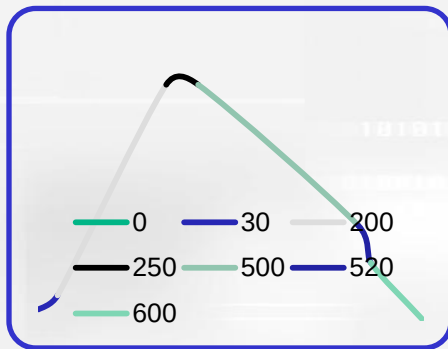
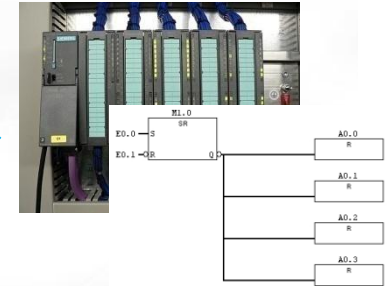
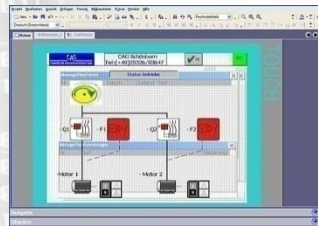


Recipe Reader





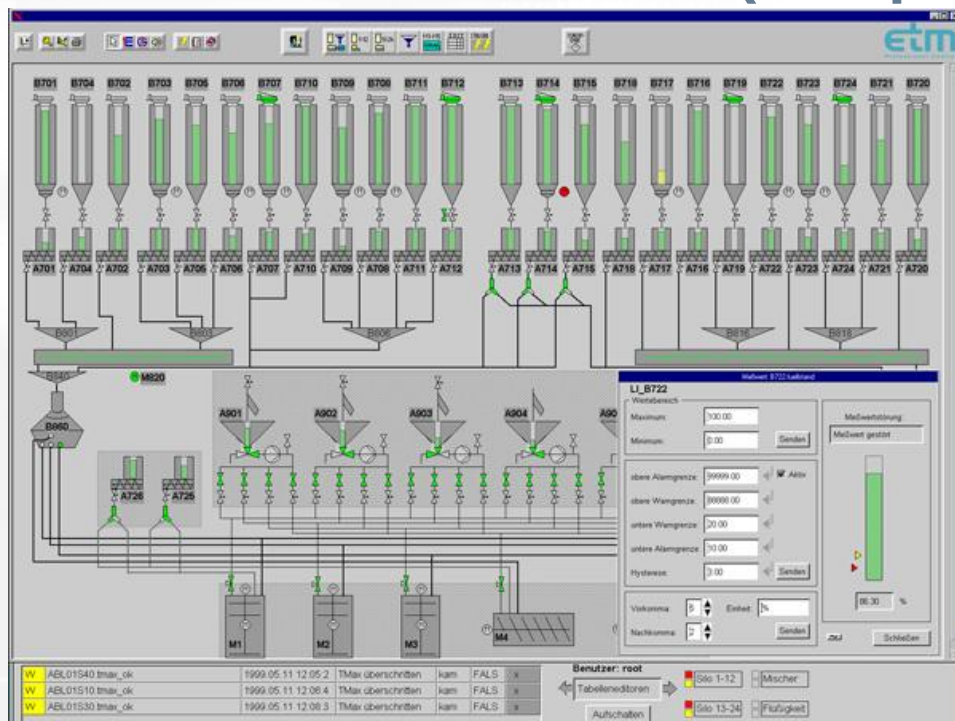
Heating Process for Aluminium Coil Furnace



Nr.	Name	Kind	Duration	Value
1	Heating	Ramp	30 min	100°C
2	Heating	Step	120 min	300°C
3	Keeping	Ramp	120 min	300°C
4	Cooling	Step	60 min	150°C
5	Colling	Ramp	30 min	50°C



Modular Batch Process (Tempering)

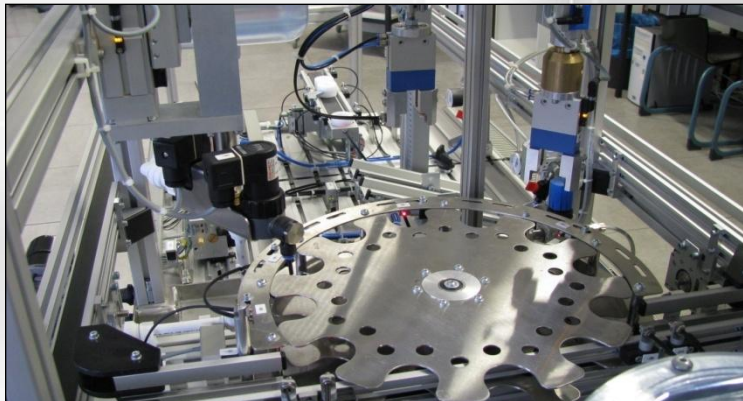


Nr.	component	Menge	Mixing time
1	sand	100 kg	0
2	grit	10 kg	10 min
3	cement	10 kg	10 min
4	water	5 kg	10 min
5	Chemical input	1 kg	10 min





Lab Application (mixing, dosing, filling)





17.06.2009

Präsentation an der Anlage



HIT



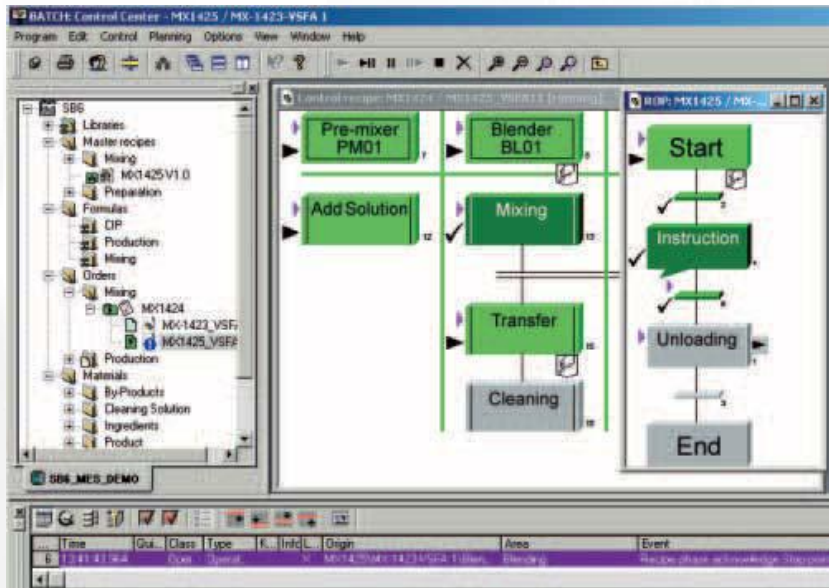
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- ## Add Ons for Process Control System

- Batch Control Center
- Batch Recipe-Editor



Batch Control Center

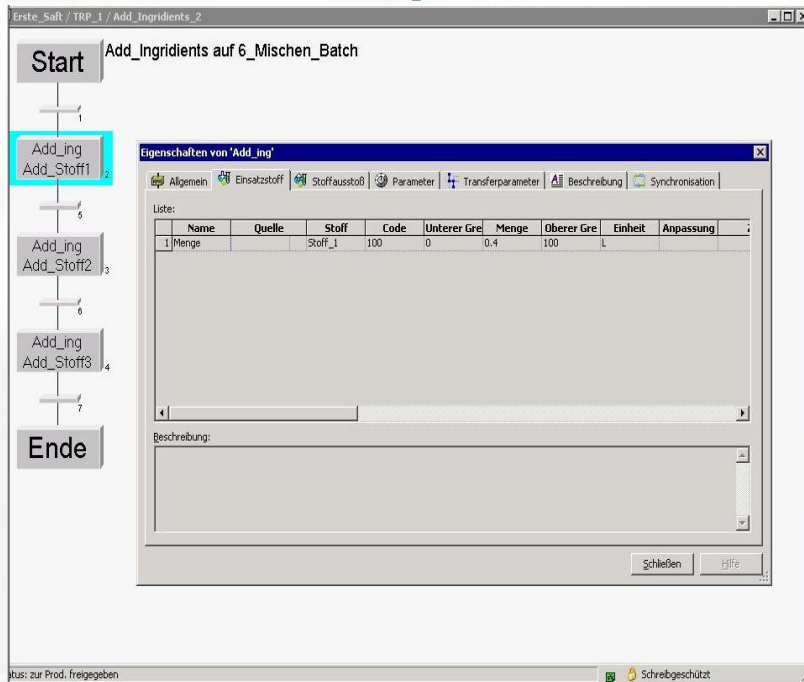


Feature of Batch CC

- Anlagendaten verwalten
- Benutzerrechte verwalten
- Rohstoffdaten
- Rezeptverwaltung
- Chargenverwaltung
- Chargenbearbeitung starten und steuern
- Chargenbearbeitung beobachten diagnostizieren
- Rezepte und Chargendaten protokollieren und archivieren

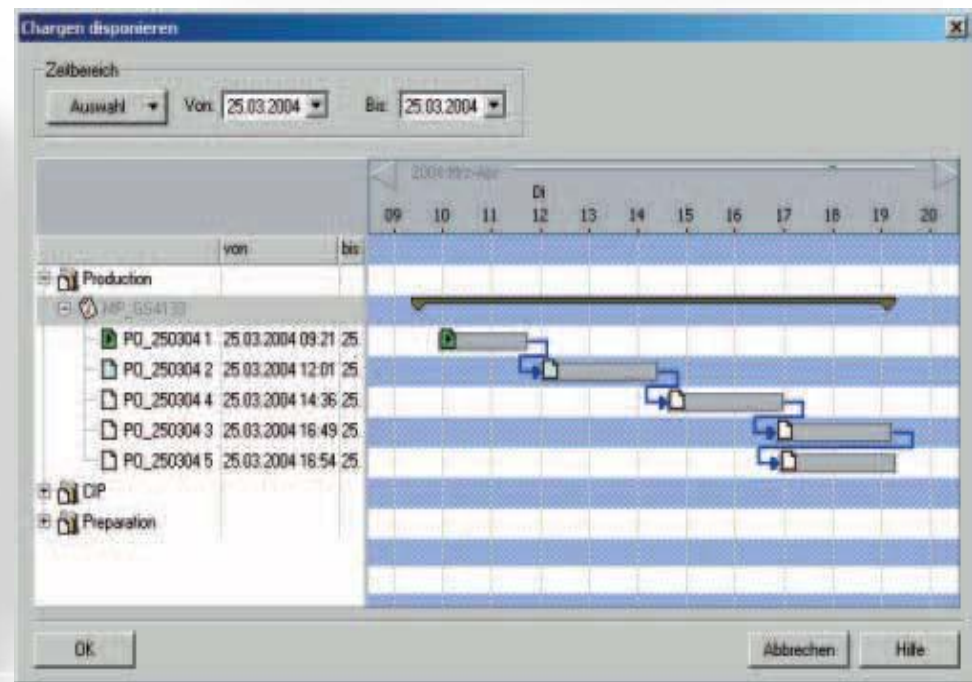


Realized Recipe



Concept of Recipe

- Definition of all input components (Name, No.)
- Quantity and Unit
- Sequence of Dosing



Concept of Charge

- Choice of Recipe
- Choice of Charging Quantity
- Choice of production line
- Choice of shedule for Start/Stop



HTW

Finish

Thank you for your attention

