Mobatec
model-based technology

Mobatec in a nutshell

Overview of Technology and Services

www.mobatec.nl

Mobatec Specialisation

Mobatec Modeller

Mathematical modelling of all kind of physical and/or chemical processes

Knowledge base → Chemical Engineering

Modelling activities for purpose of:

- Design
- Analysis
- Safety
- Optimisation
- Control
- Real time training simulation

Why Mobatec Modeller

- Use Mobatec to build your modelling infrastructure, get to know your process and get the most out of it!
- A dynamic simulation will greatly shorten startup time and significantly reduce the risk of maloperations.
- Mobatec simulations are easier to adapt, modify and integrate into the process operator world.
- Models are built in up to 2-4 times shorter time and they cost less.

- Increased complexity of models requires better tooling.
- Mobatec Modeller provides assistance in model buiding and reduces “low-level” modelling errors.

- Increased model knowledge transfer and maintainability.
- Mobatec Modeller models are easy to understand, even without having to “design and build” them.

Partial client overview

STC-GROUP

DSM
BRIGHT SCIENCE. BRIGHTER LIVING.

سابك
sabic

HUNTSMAN
Enriching lives through innovation

ExplainMedia

nyrstar
Resources for a changing world

AVEBE

TU/e Technische Universiteit Eindhoven University of Technology

lyondellbasell

Stamicarbon
pure knowledge

ACTEMIUM

Business relations

EMERSON

OTS
OPERATOR TRAINING SOLUTIONS

ExplainMedia

VORTECH

SDLC
BUSINESS DEVELOPMENT

MCPM

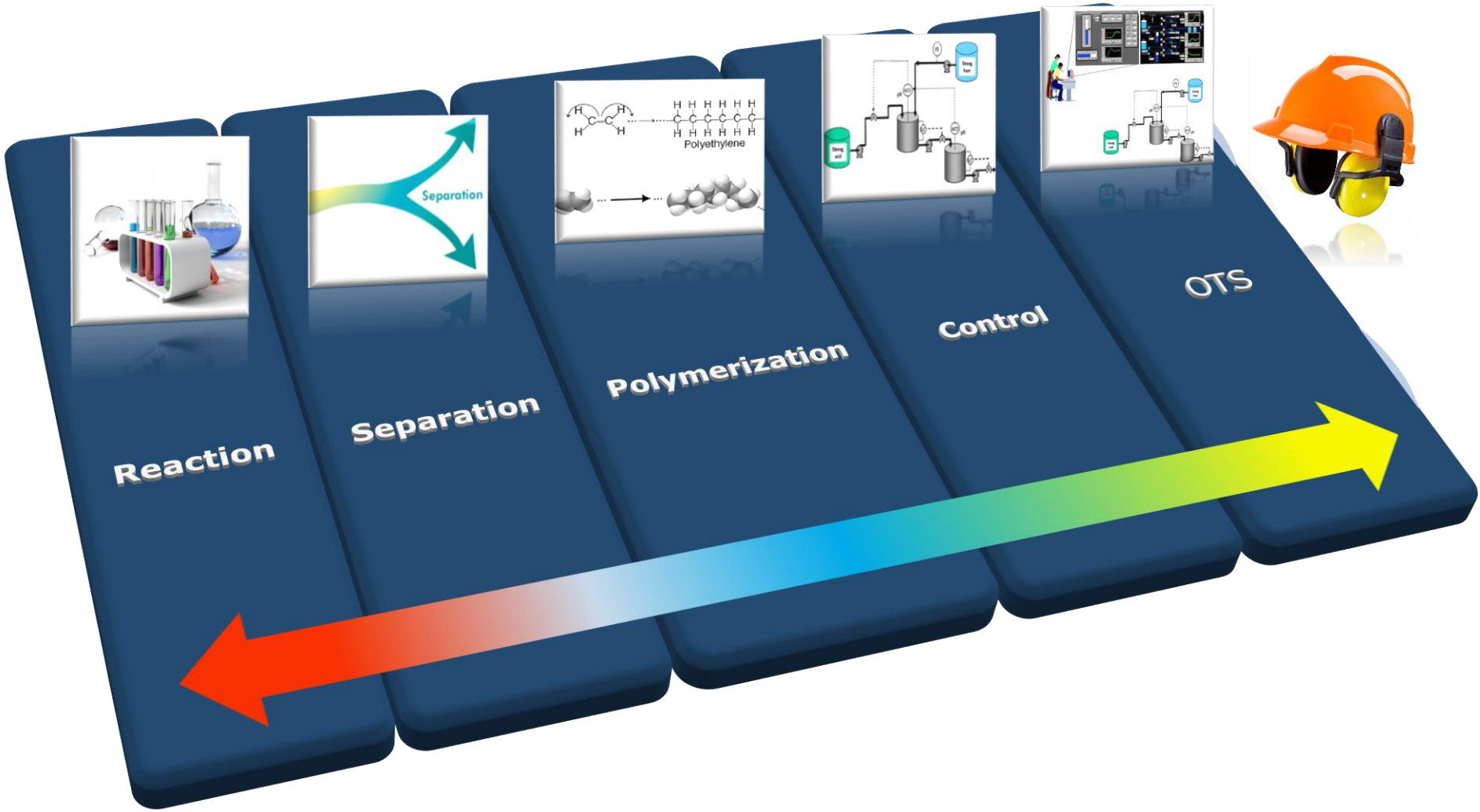
bodec

eon+

AKASHA

Primary applications & sectors

Mobatec Modeller



Mobatec provides:

Mobatec Modeller

State of the art
dynamic modelling
environment

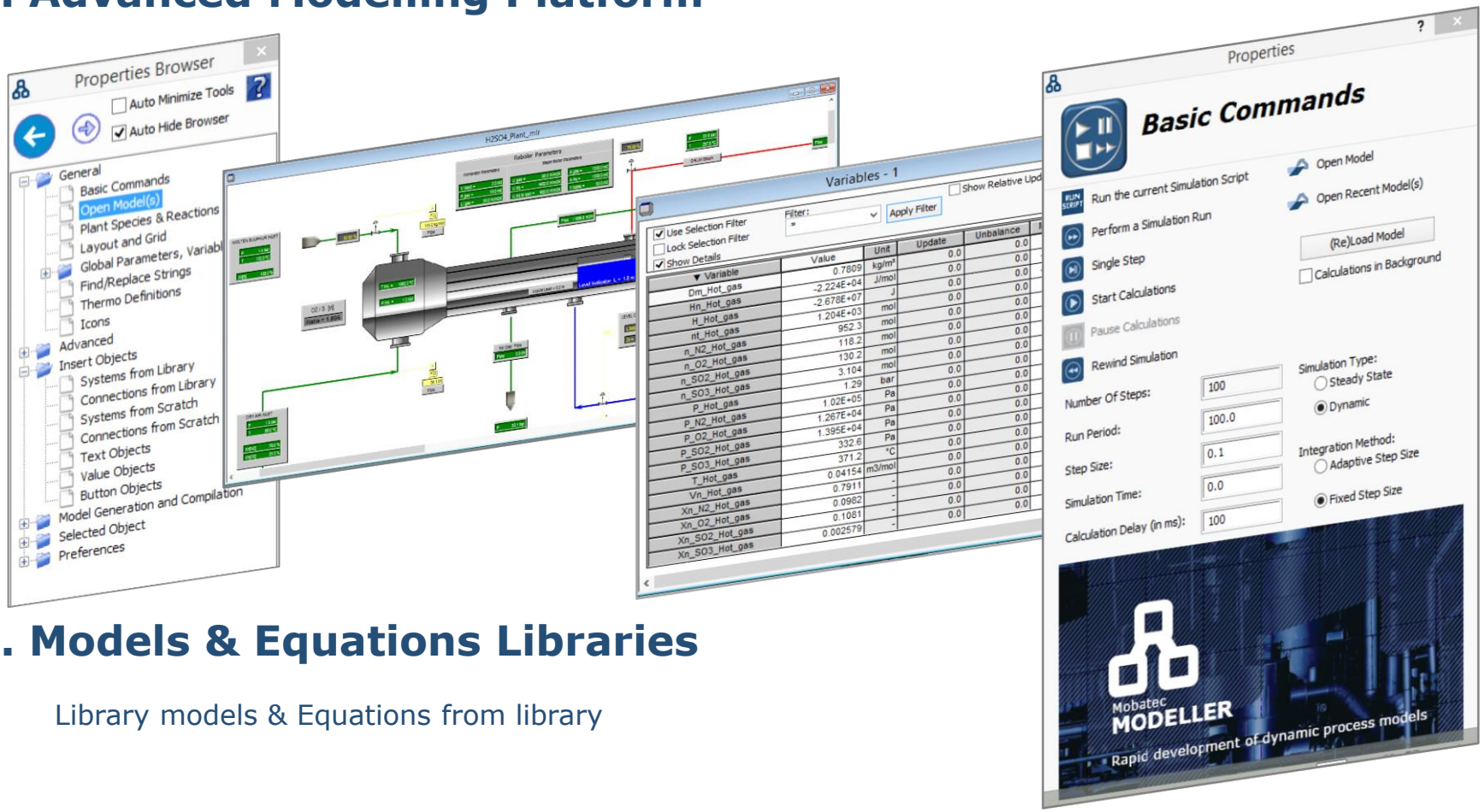
Modelling consultancy and assistance

Model building
Training
Education

Operator Training Systems

Real time operator training
Control systems testing

1. Advanced Modelling Platform



2. Models & Equations Libraries

Library models & Equations from library

3. Expert Consulting Services

Mobatec Model Care & Model Based Innovation Services

Mobatec expertise

Reactor Modelling

- Homogeneous systems
- Heterogeneous systems

Distillation (Reactive)

Stripping

Heat and Mass Transfer

- Vapour/Liquid interface
- Transfer from bulk fluid to particles
- Pore diffusion
- Adsorption on catalyst surface
- Multi-phase interactions
- Evaporation

Polymers

Crystallisation

Thermodynamics

Numerical Mathematics

Software Development of Modelling Tools

- Solver for large sets of differential and algebraic equations
- Modelling Environment
- Parameter Estimation
- Data Reconciliation

Mobatec Modeller®

Mobatec
MODELLER

Variable	Value	Unit	Update	Unbalance	Minimum	Maximum
Dm_sys0035	1.84	kg/m³	2.398E-16	4.441E-16	-1.0E+30	1.0E+30
H_sys0035	-6.265E+06	J	0.0	0.0	-1.0E+30	1.0E+30
Hn_sys0035	-1.527E+05	J/mol	2.27E-11	-9.313E-10	-1.0E+30	1.0E+30
P_sys0035	1.0	bar	-1.744E-15	1.041E-22	-1.0E+30	1.0E+30
T_sys0035	20.0	°C	-5.988E-13	5.821E-11	5.0	250.0
Vn_sys0035	0.02437	m3/mol	2.706E-18	-1.11E-16	-1.0E+30	1.0E+30
Xn_Acetone_sys0035	10.0	%	0.0	0.0	-1.0E+30	1.0E+30
Xn_Butanone2_sys0035	10.0	%	0.0	0.0	-1.0E+30	1.0E+30
Xn_H2O_sys0035	10.0	%	0.0	0.0	-1.0E+30	1.0E+30
Xn_MeOH_sys0035	10.0	%	0.0	0.0	-1.0E+30	1.0E+30
Xn_N2_sys0035	20.0	%	0.0	0.0	-1.0E+30	1.0E+30
Xn_O2_sys0035	20.0	%	0.0	0.0	-1.0E+30	1.0E+30
Xn_tertBuOH_sys0035	20.0	%	0.0	0.0	-1.0E+30	1.0E+30
n_Acetone_sys0035	4.103	mol	0.0	0.0	0.0	1.0E+30
n_Butanone2_sys0035	4.103	mol	0.0	0.0	0.0	1.0E+30
n_H2O_sys0035	4.103	mol	0.0	0.0	0.0	1.0E+30
n_MeOH_sys0035	4.103	mol	0.0	0.0	0.0	1.0E+30
n_N2_sys0035	8.206	mol	0.0	0.0	0.0	1.0E+30
n_O2_sys0035	8.206	mol	0.0	0.0	0.0	1.0E+30
n_tertBuOH_sys0035	8.206	mol	0.0	0.0	0.0	1.0E+30
nt_sys0035	41.03	mol	0.0	0.0	-1.0E+30	1.0E+30

Free Demo

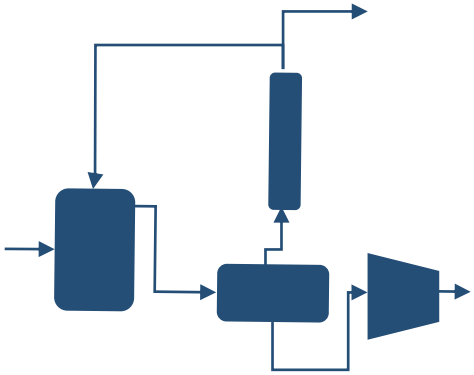
The **free** demo-version of Mobatec Modeller includes **Examples** and **Learning Modules.**

Go to **www.mobatec.nl** and download it for free!

Approaches towards Modelling

Mobatec Modeller

Flow-Sheeters:



- ✓ **Black-box** models
- ✓ Low flexibility
- ✓ Sequential calculation - Recycle problems
- ✓ Good only for rough estimates
- ✓ No knowledge on the models needed

Equation Oriented:

```
! System Equations:

! System Buffer_Tank   (3)
! Balance Equations
pivot =  m_H2O_Buffer_Tank
d(m_H2O_Buffer_Tank)/dt == Fm_H2O_Fin - Fm_H2O_Fout
! Algebraic Equations
pivot =  A_Buffer_Tank
A_Buffer_Tank == D_Buffer_Tank * D_Buffer_Tank * 3.141592653589793 / 4
pivot =  M_Buffer_Tank
M_Buffer_Tank == (m_H2O_Buffer_Tank)
pivot =  L_Buffer_Tank
M_Buffer_Tank == rho_Buffer_Tank * A_Buffer_Tank * L_Buffer_Tank
```

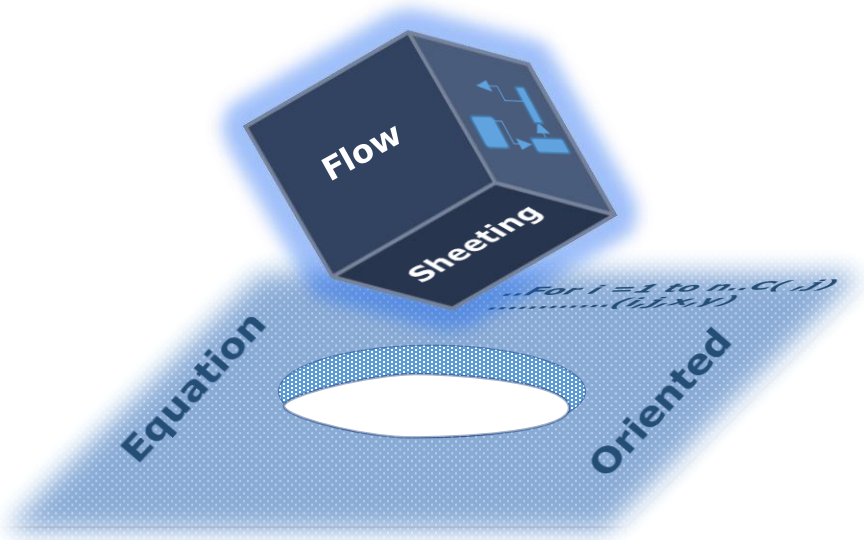
- ✓ White box models
- ✓ High flexibility – **low transparency**
- ✓ No Recycle problems
- ✓ Knowledge on the models needed
- ✓ Good for High-Fidelity simulations
- ✓ **Programming skills needed**

The MM approach

Equation Oriented..

Flow Sheeters..

What is the missing link ?

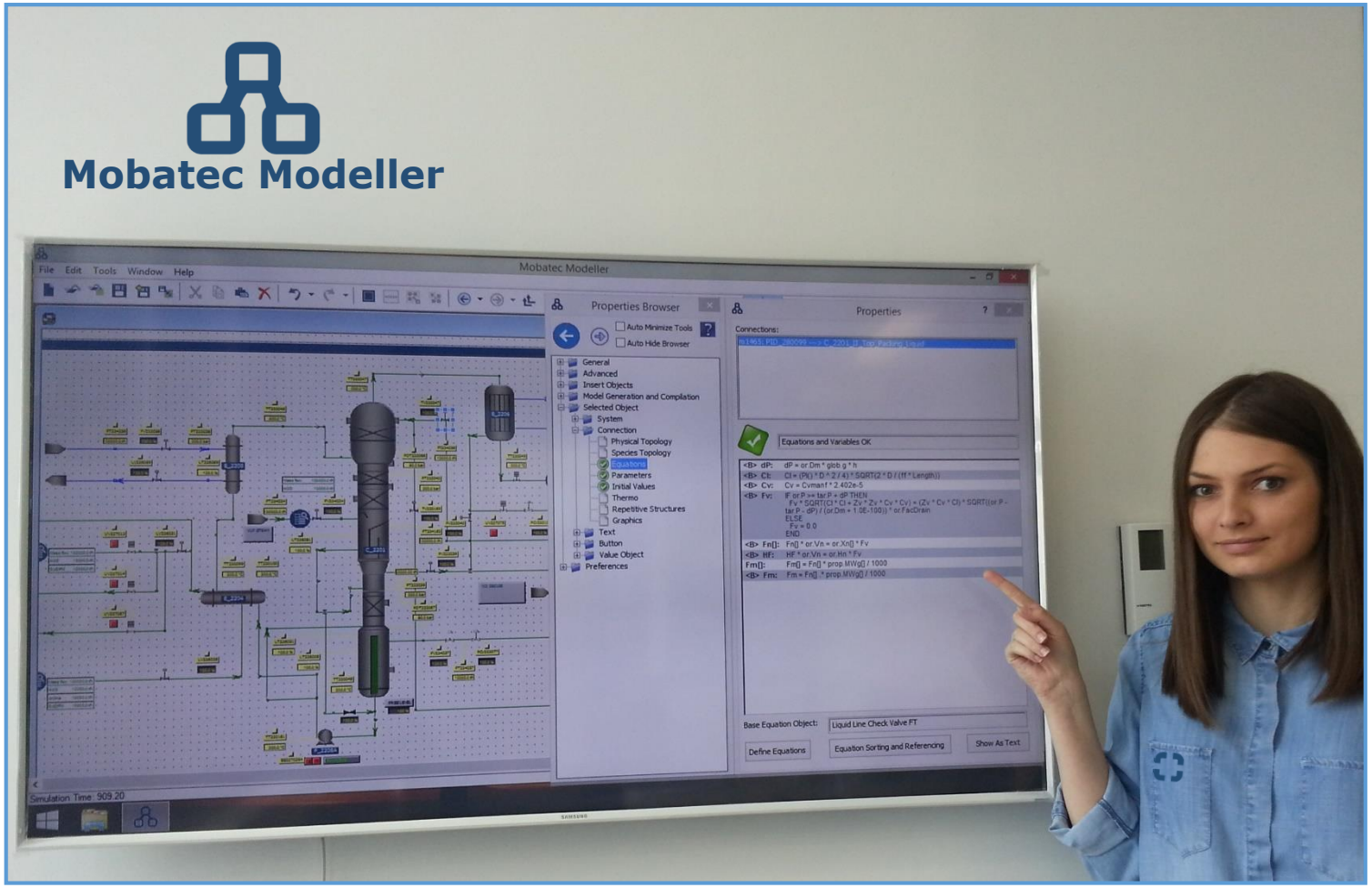


Equation Oriented Flow Sheeter!

Mobatec Modeller

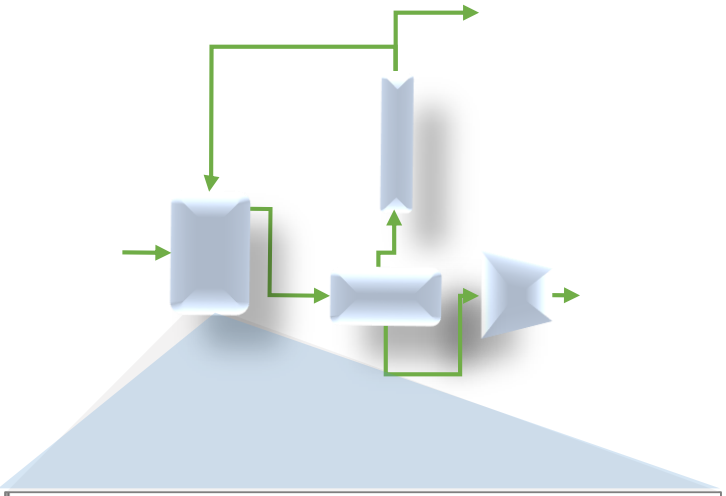
Equation and **S**ystem based

The MM approach



Mobatec Modeller is:

Equation and System based



```
! System Equations:

! System Buffer_Tank   (3)
! Balance Equations
pivot =  m_H2O_Buffer_Tank
d(m_H2O_Buffer_Tank)/dt == Fm_H2O_Fin - Fm_H2O_Fout
! Algebraic Equations
pivot =  A_Buffer_Tank
A_Buffer_Tank == D_Buffer_Tank * D_Buffer_Tank * 3.141592653589793 / 4
pivot =  M_Buffer_Tank
M_Buffer_Tank == (m_H2O_Buffer_Tank)
pivot =  L_Buffer_Tank
M_Buffer_Tank == rho_Buffer_Tank * A_Buffer_Tank * L_Buffer_Tank
```

- ✓ White box models → (knowledge of models needed)
- ✓ Flexible → high transparency
- ✓ No Recycle problems
- ✓ High-Fidelity simulations
- ✓ Programming skills **NOT** needed
- ✓ Assistance on Initialization
- ✓ Assistance on "DOF"
- ✓ Equations written (almost as on paper!) and added to the systems by the user
- ✓ Code generated by Mobatec Modeller (automatically)
- ✓ Complex models look & feel like sum of simple models!
- ✓ Easy connection to any DCS provider!

Model building process..

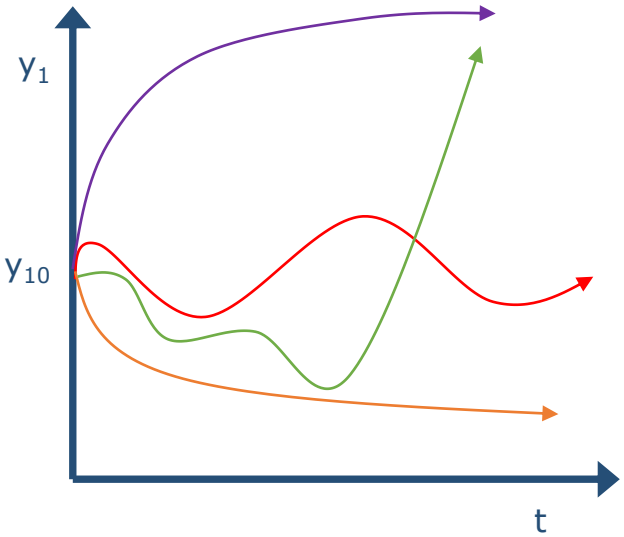
Mobatec Modeller

$$dT/dt=[\Delta H_{Rx}(r_A V) - [UD(T-T_a) + \Sigma F_{io}Cp_i(T-T_0)]]/ \Sigma N_{io}Cp_i$$

$$VdC_A/dt = \upsilon_0[C_{ao}-C_A] + r_A V$$

$$\Sigma F_{io}Cp_i = \upsilon_0 \Sigma C_{io}Cp_i = \upsilon_0 C_{Ao} \Sigma \theta_i Cp_i = \upsilon_0 C_{Ao} Cp_s$$

$$\Sigma N_{io}Cp_i = V \Sigma C_i Cp_i = V_0 C_{Ao}Cp_s$$




```
! System Equations:

! System COMPRESSOR_DISCHARGE   (1.1)
! Balance Equations
pivot =  n_H2_COMPRESSOR_DISCHARGE
d(n_H2_COMPRESSOR_DISCHARGE)/dt == Fn_H2_COMPRESSOR_L - Fn_H2_m0019
pivot =  n_NH3_COMPRESSOR_DISCHARGE
d(n_NH3_COMPRESSOR_DISCHARGE)/dt == Fn_NH3_COMPRESSOR_L - Fn_NH3_m0019
pivot =  n_N2_COMPRESSOR_DISCHARGE
d(n_N2_COMPRESSOR_DISCHARGE)/dt == Fn_N2_COMPRESSOR_L - Fn_N2_m0019
pivot =  H_COMPRESSOR_DISCHARGE
d(H_COMPRESSOR_DISCHARGE)/dt == HF_COMPRESSOR_L - HF_m0019
! Algebraic Equations
pivot =  nt_COMPRESSOR_DISCHARGE
nt_COMPRESSOR_DISCHARGE == (n_H2_COMPRESSOR_DISCHARGE +
n_NH3_COMPRESSOR_DISCHARGE + n_N2_COMPRESSOR_DISCHARGE)
pivot =  Xn_H2_COMPRESSOR_DISCHARGE
n_H2_COMPRESSOR_DISCHARGE == Xn_H2_COMPRESSOR_DISCHARGE *
nt_COMPRESSOR_DISCHARGE
pivot =  Xn_NH3_COMPRESSOR_DISCHARGE
n_NH3_COMPRESSOR_DISCHARGE == Xn_NH3_COMPRESSOR_DISCHARGE *
nt_COMPRESSOR_DISCHARGE
…
```

Mobatec Modeller approach

Mobatec Modeller

Equation and system based

Dynamic or Steady State

Mass & Energy balances for free (generated by MM)

No programming needed (MM generates the code)

Library of models & equations

Easy extendable libraries for predefined units

High flexibility when incorporating existing user models

Assistance with DOF of systems

Assistance with initialization

Equations physical topology

Easy to understand

User's perspective

✓ **Equation oriented flow-sheeter**

Custom equation based modelling and "drag-&-drop" flow-sheeting

✓ **No programing skills needed:**

Mobatec Modeller generates the code for you

✓ **Manual model initialization:**

Ensures a good starting calculation point every time

✓ **Equation physical topology:**

High model transparency and maintainability, making any model very easy to understand

Technology prospective

Differential & **A**lgebraic **E**quation (DAEs) solution engine solves models with hundreds of thousands of equations simultaneously

Modelling purposes

Design

Analysis

Safety

Optimisation

Control

Real time
training simulation

Interested in learning more? ➔ http://www.mobatec.nl/web/downloads/

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