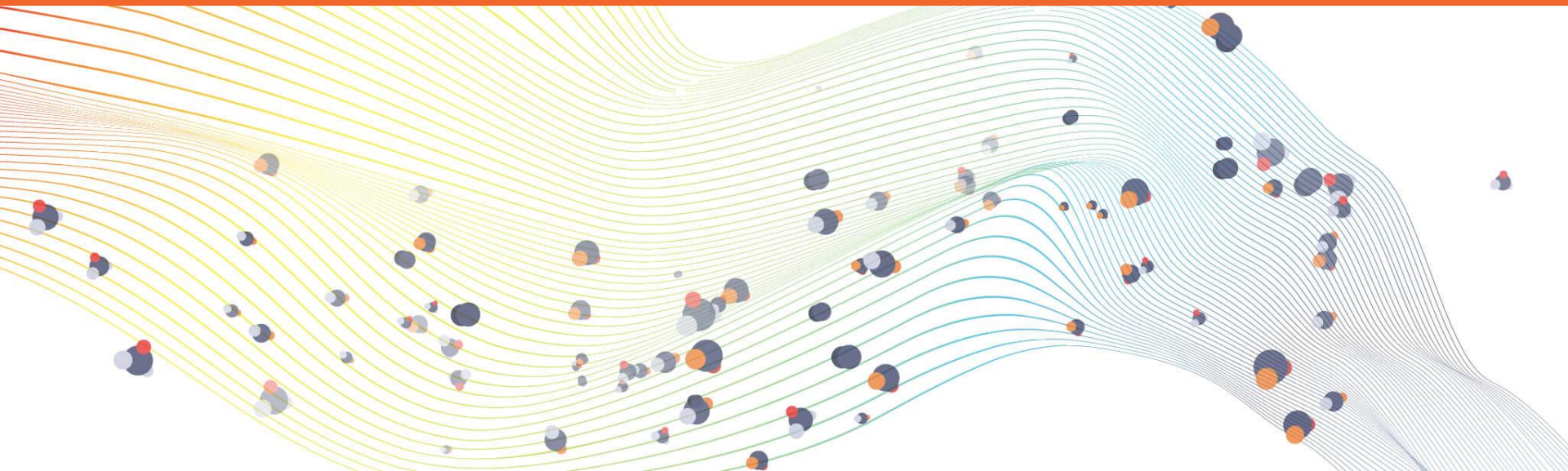
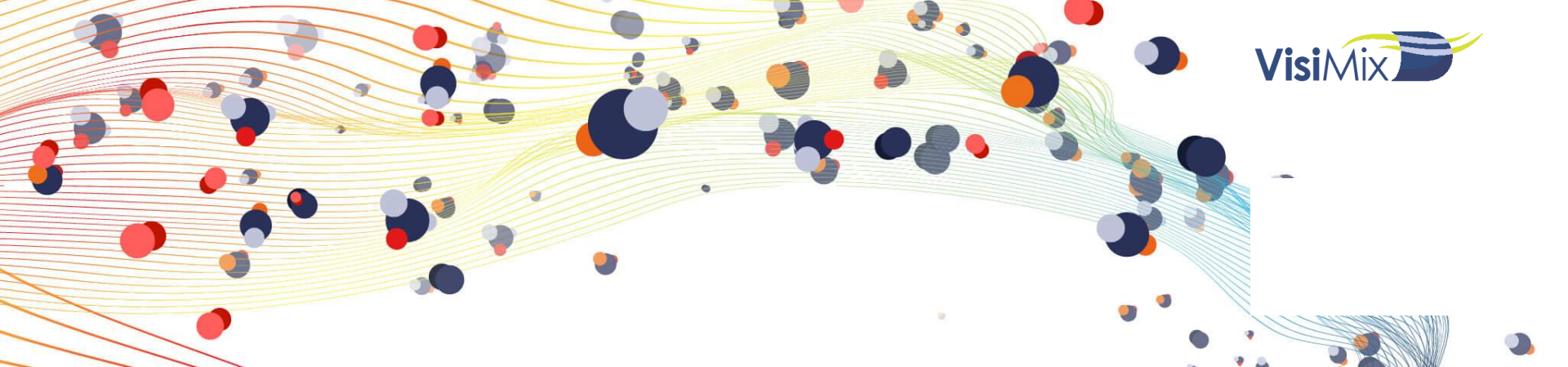




Simulation of Mixing Processes





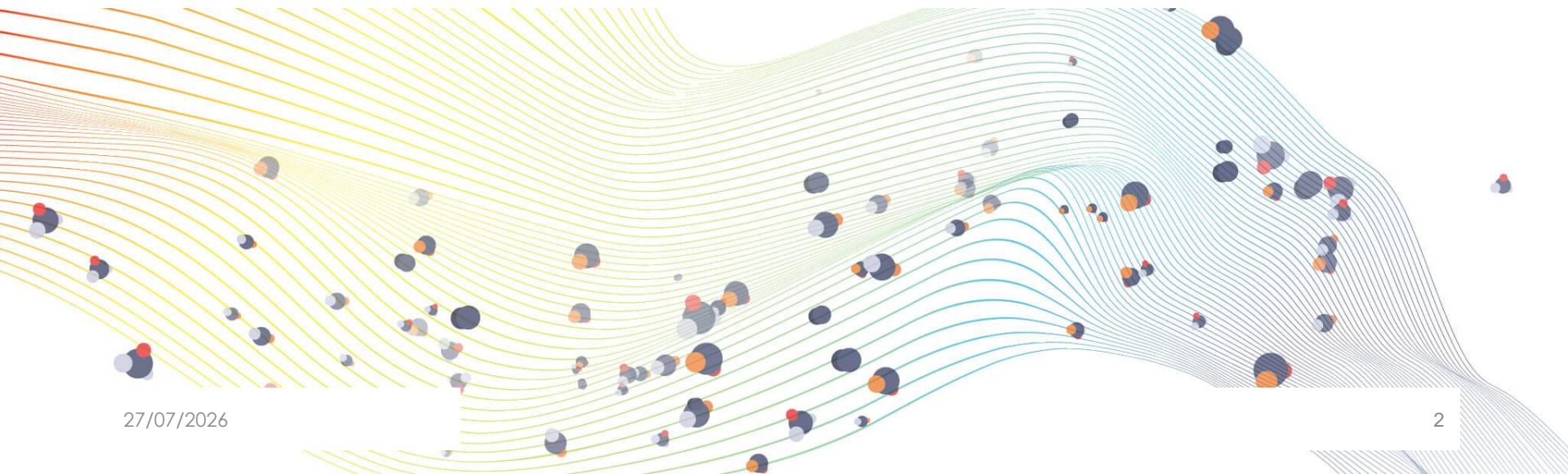
JOIN US AT THE

Nineteenth VisiMix Forum

Chemical Reaction Simulation under Mixing in Stirred Vessel

REGISTER NOW >

▶ 28.7.26 | 15:00 EUR, 09:00AM EDT





VisiMix presents

VisiMix Chem



Dr. Moshe Bentolila



Visimix Chem

Simulation of
Real-world
chemical reactor
dynamics

**A unified platform for data exchange and active collaboration
between chemists and chemical engineers**

About Us

VisiMix.Ltd is a unique software enabling chemical engineers, process engineers and R&D personnel to characterize and visualize mixing processes via a simple, user-friendly interface.



Our products allow significant savings in time and costs by drastically reducing the need for trial-and-error. They have been successfully adopted by hundreds of companies.

VisiMix Background

Established in 1995

1995-1998 – Developed the VisiMix Turbulent Product

1998-2000 – Developed the VisiMix Laminar Product

2000-2003 – Developed the VisiMix Different Impellers Product

2003-2004 – Developed the VisiXcel Product

2007-2010 – Developed the VisiMix RSD Product

2011-2013 – Developed the VisiMix Emulsification Product

2014-2017 – Developed the VisiMix 3D, Hydrofoils Blades and Alternative impellers

2018-2019 – Developed Off Center Impellers

2020-2022 – Developed Scale Up/Down, Process Evaluation

2023-2024 – Developed VisiMix Chem

2025-2026 – Developed VisiMix Sensitivity Analysis

Today VisiMix has More than 300 Customers 20 professional workers

Simple and Effective

Technology - Simulation of Mixing Processes

- The First and the only tool in the Industry
- Reliable and accurate results
- Based on More Than 300 Man Years of R&D and Industry Experience
- Replacing Pilot Experiments
- Accelerated Time-to-Market process
- User Friendly and easily accessible



About Us

- VisiMix is based on a physical models supported by empirical data , in a way that solves momentum balances depending on the existing equipment.
- The phenomena of the flow in the vessel is considered using many theories such as the **Mixing Length of Prandtl theory, Kolmogorov theory** and many others describing one or more phase systems.
- Considering this and all the experimental coefficients that were evaluated, it is possible to **calculate many mixing parameters** corresponding to a specific process using VisiMix and **their influence in the process.**

Customers & Markets



BASF
The Chemical Company



Pfizer



Lubrizol



Merck KGaA
Darmstadt, Germany



TEVA



3M



Siegfried



FMC



De Dietrich
T H E R M I Q U E

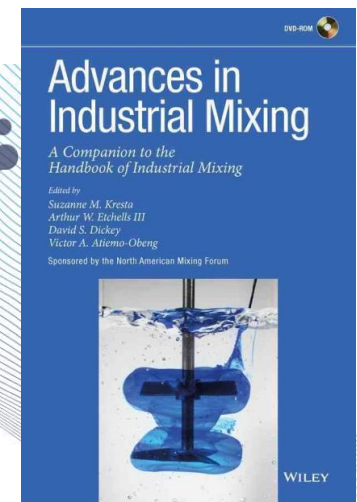
What Our Customers Say About Us

From the Dow Chemicals Intranet Website

“VisiMix: This is a **highly accessible PC software** for mixing calculations available from VisiMix Ltd., an Israeli company. It is a **rating calculation tool** for both non-reactive and reactive mixing involving blending, solid suspension, gas dispersion, liquid-liquid dispersion, or heat transfer processes in stirred vessels. It calculates the important process parameters for single- and two-phase systems – power consumption, circulation rates, local concentrations of solutes and suspended particles, drop size, concentrations of reactants, etc ...”

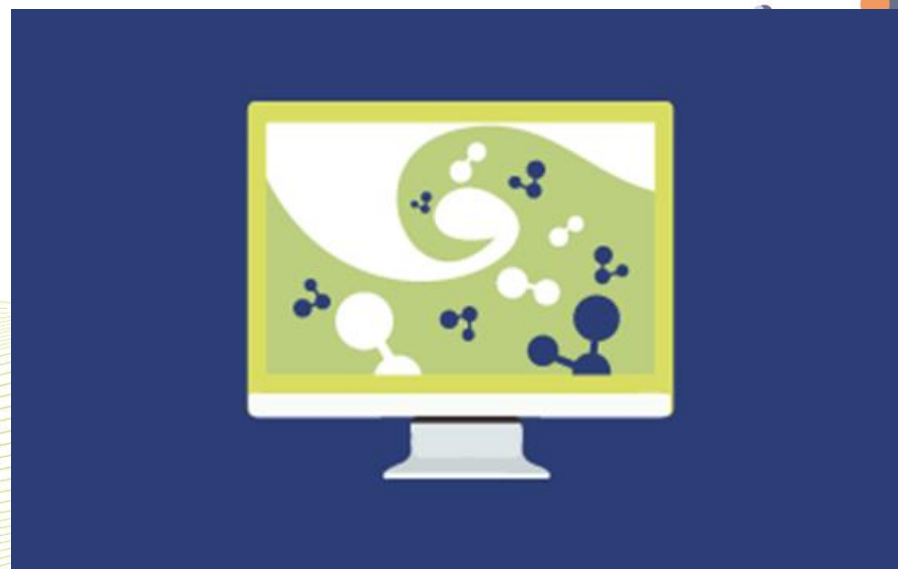
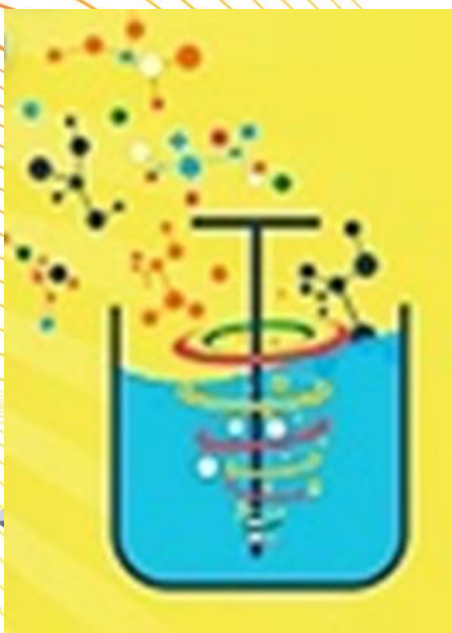
Dr. Victor Atiemo-Obeng

Dow Chemicals Co.



VisiMix Chem

Real-world chemical reactor dynamics



VisiMix Chem

Real-world chemical reactor dynamics

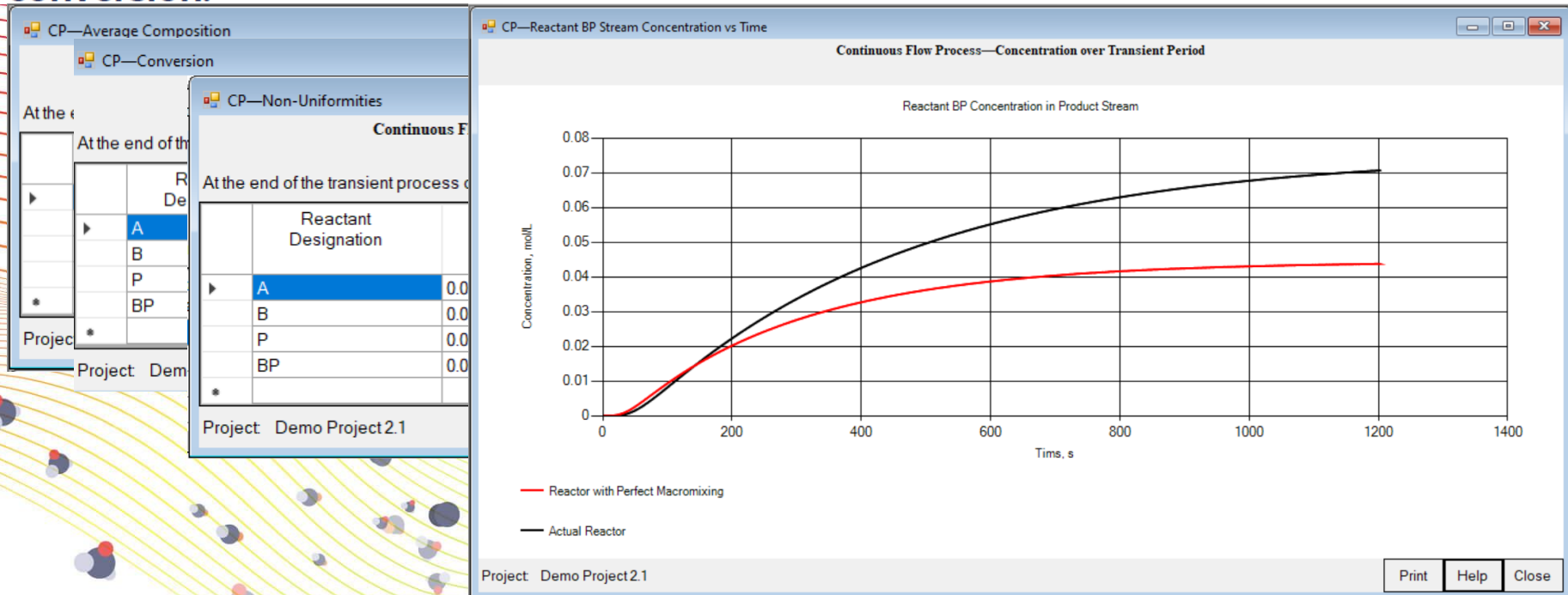
A unified platform for data exchange and active collaboration between chemists and chemical engineers

- ♦ **Rapidly obtain** reliable information about each reactant concentration in a **real-world** mixing reactor, where macromixing and micromixing processes interact with chemical kinetics
- ♦ **Scale-up** to the industrial scale a process successfully implemented at the laboratory scale
- ♦ **Analyze** the **product output and purity** as functions of initial reactant concentrations, feed chemical composition, mixing system design, inlet point positions, etc.

VisiMix Chem

Real-world chemical reactor dynamics

Visimix Chem enables a user to look into a REAL-WORLD mixing reactor by rapidly obtaining RELIABLE information about each reactant concentration and conversion:



VisiMix Chem

Real-world chemical reactor dynamics



A unified platform for data exchange and active collaboration between chemists and chemical engineers specializing in different phases of new product development at the lab, pilot, and production scales.



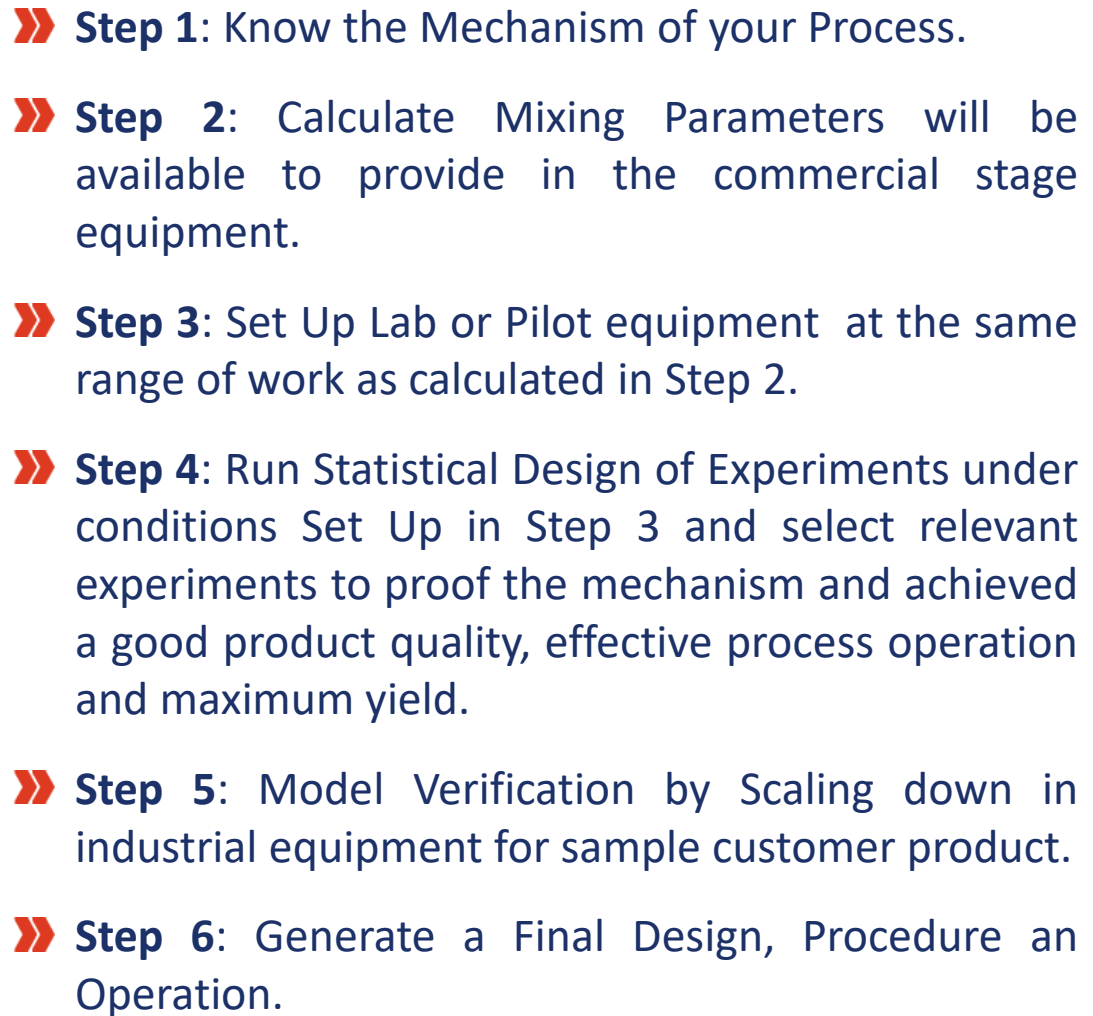
Visimix Chem enables a **CHEMIST** to present in a unified language:

- ◇ results of laboratory work suitable for scale-up and knowledge transfer
- ◇ characteristics of a problematic industrial process for scale-down and subsequent laboratory investigation

Visimix Chem enables a **CHEMICAL ENGINEER** to:

- ◇ reliably select optimal equipment and its best operation conditions for process development at the pilot or production scales
- ◇ design new equipment

Celebrating three decades of our accomplishments in mixing simulation, Visimix presents Visimix Chem, a revolutionary product for simulating real-world chemical reactor dynamics. Visimix Chem is completely compatible with Visimix Turbulent.



VisiMix Chem

Real-world chemical reactor dynamics

- Up to 8 components
- Accounting for solvent *MW* and *T* for correct estimation of diffusivity

Process temperature		26.0 °C	Solvent molar mass, g/mol		18
	Designation	Description	Molar mass, g/mol	Initial in the Tank	
X	S	Treated Polysaccharide	2646	0.00111	
X	E	Amylase	52250	1.4E-05	
X	P1	Glucose	180		
X	P2	Maltose	342		
X	SE	Complex 1	54896		
X	SEU	Complex 2	2646		

- Up to 5 chemical reactions
- Catalysis and inhibition
- Accounting for solvent *MW* and *T* for correct estimation of diffusivity

Designation	Description
R1	Reversible enzyme addition $S + E \leftrightarrow SE$
R2	Hydrolysis $SE \leftrightarrow E + SEU$
R3	secondary complex decomposition $SEU \leftrightarrow 3 P1 + P2$

VisiMix Chem

Real-world chemical reactor dynamics

Processes:

- Batch, semibatch
- Continuous

Comparison of perfect macromixing and real mixing

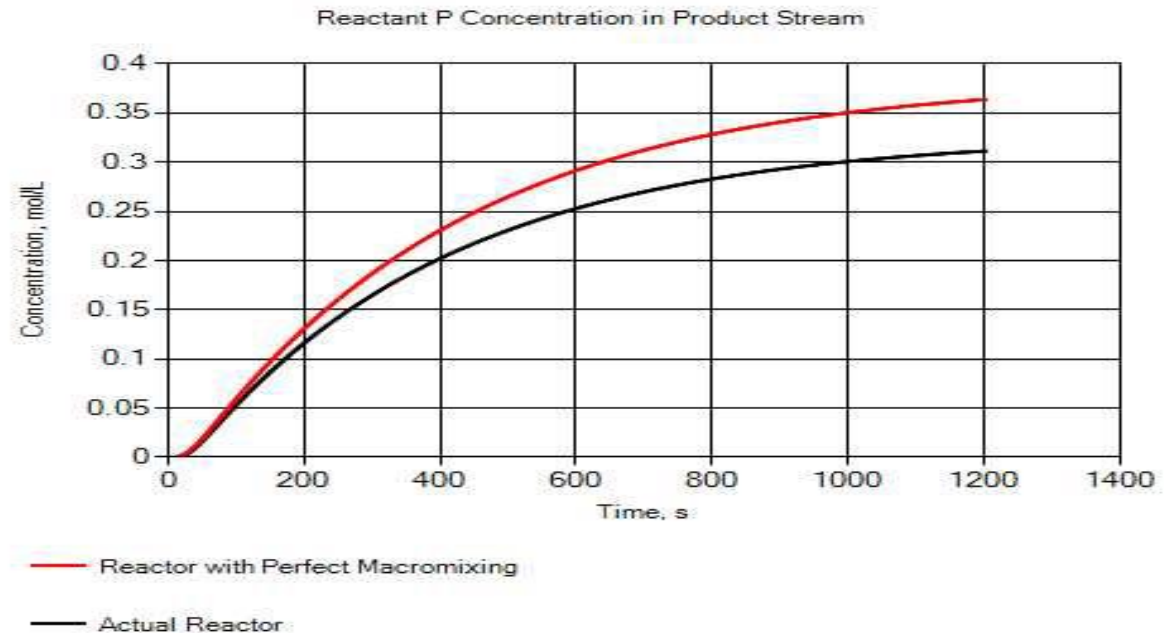
Batch/Semi-batch:

- Concentration
- Conversion

Continuous:

- Concentration
- Conversion
- Non-uniformity

Continuous Flow Process—Concentration over Transient Period



	Reactant Designation	Actual Reactor—Tank	Actual Reactor—Product Stream	Reactor with Perfect Macromixing
▶	A	0.06117	0.02273	0.02665
	B	0.04054	0.09427	0.07044
	P	0.3136	0.3114	0.3638
	BP	0.07411	0.07071	0.04379
*				

VisiMix Chem

Real-world chemical reactor dynamics

Databases

- **Project Database**

- Equipment
- Liquids
- Process
- Keywords and description for ease of searching

- **Fluids Database**

- Density
- Viscosity (Newtonian and Non-Newtonian)

VisiMix Chem

Real-world chemical reactor dynamics

Field of Application of the Program

The software input supports a convenient format for entering chemical kinetics into the simulations, and allows user to analyze the effect of inlet point positions, chemical composition of the inlet flow, mixing system design, etc.

Field of Application of the Program

- **VisiMix Chem** is developed for simulation of dynamics of stirred chemical reactors operated in the turbulent flow regime and utilizes the sophisticated **Visimix Turbulent** models for simulation of all hydrodynamic mixing processes.
- Using tank design, agitator or rotor speed, fluid rheology and feed flow rates as input, these models support analysis of **fluid dynamics variables**, i.e., pressure, velocity, circulation flow rate and local turbulence characteristics (such as local energy dissipation, ε , and the smallest scale of turbulence fluctuations, δ), **which determine local macromixing and micromixing characteristics**.
- **VisiMix Chem** calculations are conducted for actual chemical reactors where neither macromixing nor micromixing is ideal, and results of these calculations are compared in all output tables and charts against respective calculations conducted for a respective **reactor with perfect macromixing**.

VisiMix Chem

Real-world chemical reactor dynamics

Rational

- A.** Using design characteristics of a reactor, calculate the primary hydrodynamic characteristics, such as:
 - I.** (i) rotational, radial and axial velocities in the tank
 - II.** (ii) turbulent energy dissipation and turbulent diffusivity in individual large-scale zones of the reactor.
- B.** Based on the primary characteristics of the turbulent flow generated at Step A, obtain the secondary flow characteristics, which govern macroscale and microscale mixing in the tank.

VisiMix Chem

Real-world chemical reactor dynamics

Rational

- C.** Finally, obtain local concentration of reactants based on both primary (hydrodynamics) and secondary (mixing) characteristics of turbulence in the tank.
- D.** Scale-up to the industrial scale (where significant nonuniformities of local concentration occur and their impact on product purity is high) a process successfully implemented at the laboratory scale (where mixing time is very small, mixing is almost perfect, and its impact on product purity is negligible).

Brief Description of Mixing Phenomena

- The goal of mixing is to minimize non-uniformities in chemical composition over the volume of fluid in a chemical reactor.
- These non-uniformities occur in a continuous range of scales that can be conditionally divided into two levels: **macroscopic** and **microscopic**.
- The smallest scale of turbulence fluctuations (so called Kolmogorov's scale) is adopted as a conditional border between **macroscopic** and **microscopic** scales.
- The Kolmogorov's scale is estimated as $\delta = \frac{v^{0.75}}{\varepsilon^{0.25}}$

Brief Description of Mixing Phenomena

Macromixing Time

- **Macromixing** is a process of mixing at a macroscopic level exceeding δ . It is achieved by creating turbulence of necessary intensity in a reactor.
- Perfect macromixing is a state where chemical composition of any macroscopic volume (i.e., a volume of a size exceeding δ) is uniform over the entire volume of fluid in a mixing tank at any given moment.
- A chemical ***reactor with perfect macromixing*** is an ideal reactor where perfect macromixing is achieved.
- However, local non-uniformities can exist in a ***reactor with perfect macromixing*** at a microscopic level, and such a reactor is different from a ***perfectly mixed reactor*** where no non-uniformities exist at both **macroscopic** and **microscopic** levels.

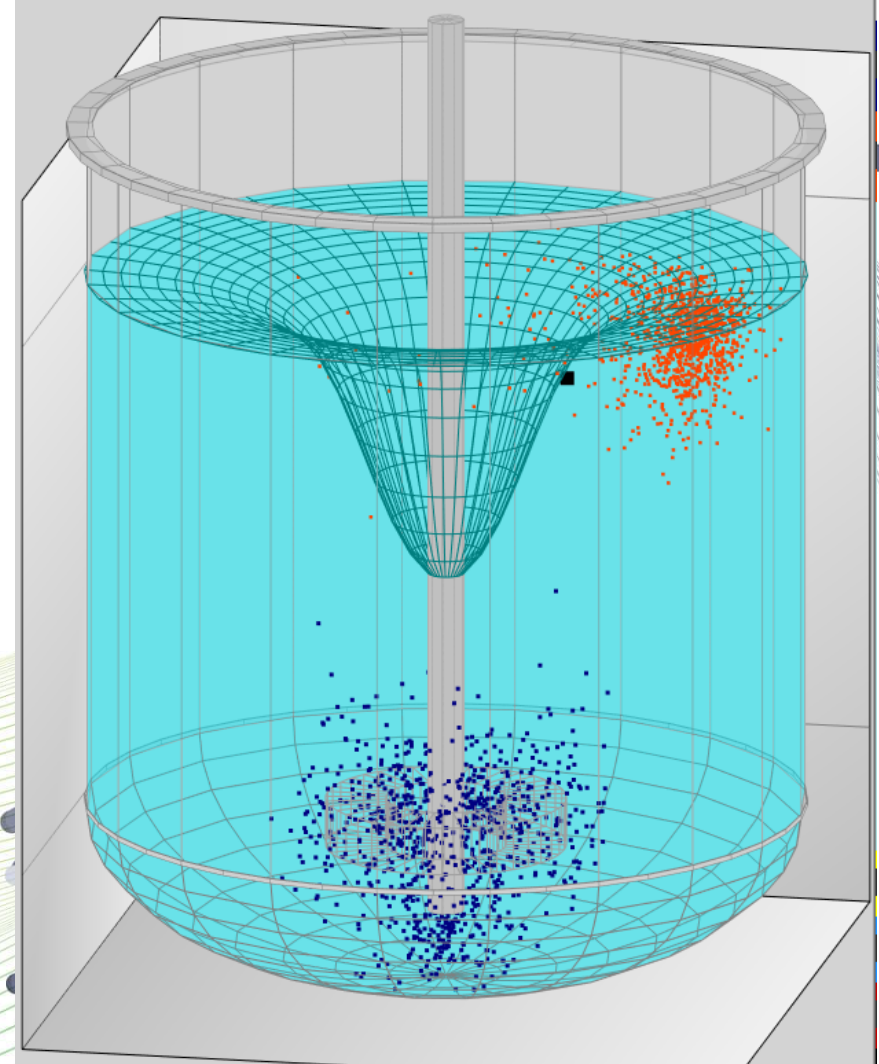
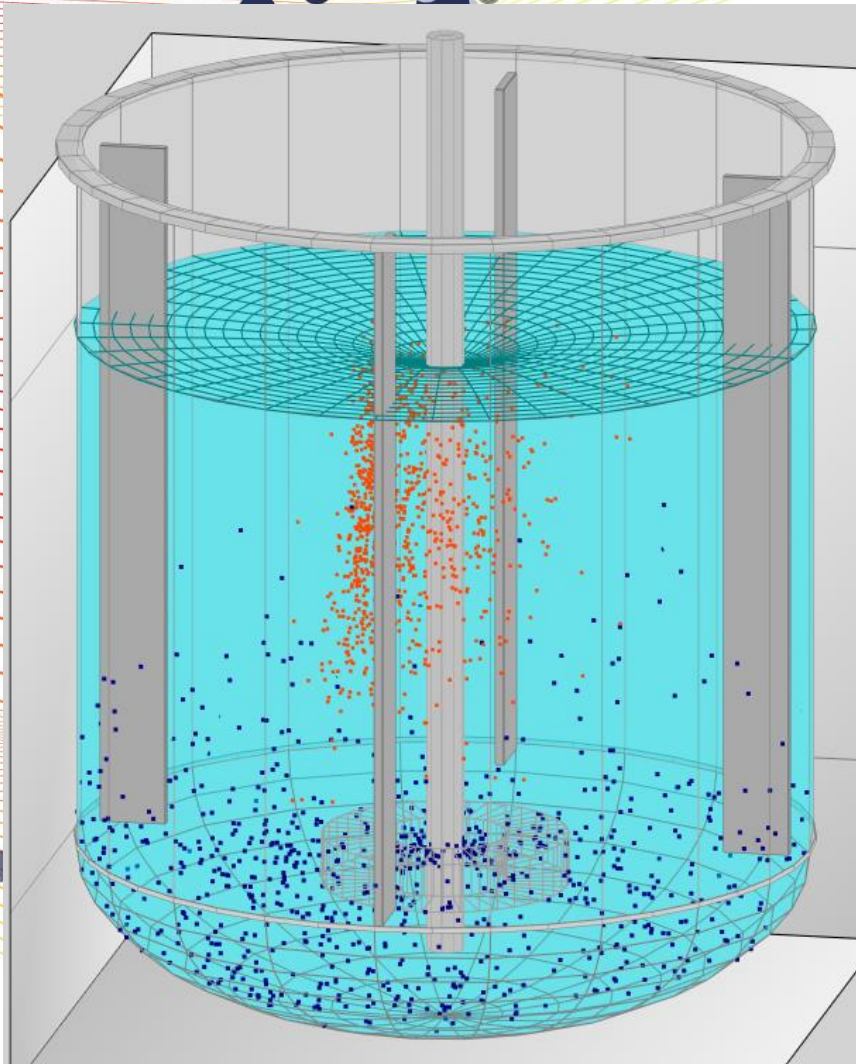
Brief Description of Mixing Phenomena

Characteristic time of micromixing

- **Micromixing** is a process of mixing at a microscopic scale, which is below δ . It occurs via molecular diffusion as no turbulent fluctuations exist at such a small scale.
- The characteristic time, τ , of micromixing (i.e., mixing inside a volume of size δ) can be estimated as $\tau = \frac{\delta^2}{D_m}$ where D_m is an effective molecular diffusivity of reactants in liquid.
- Substituting equations, we obtain the following correlation between the characteristic time of micromixing, τ , and local energy dissipation, ε :

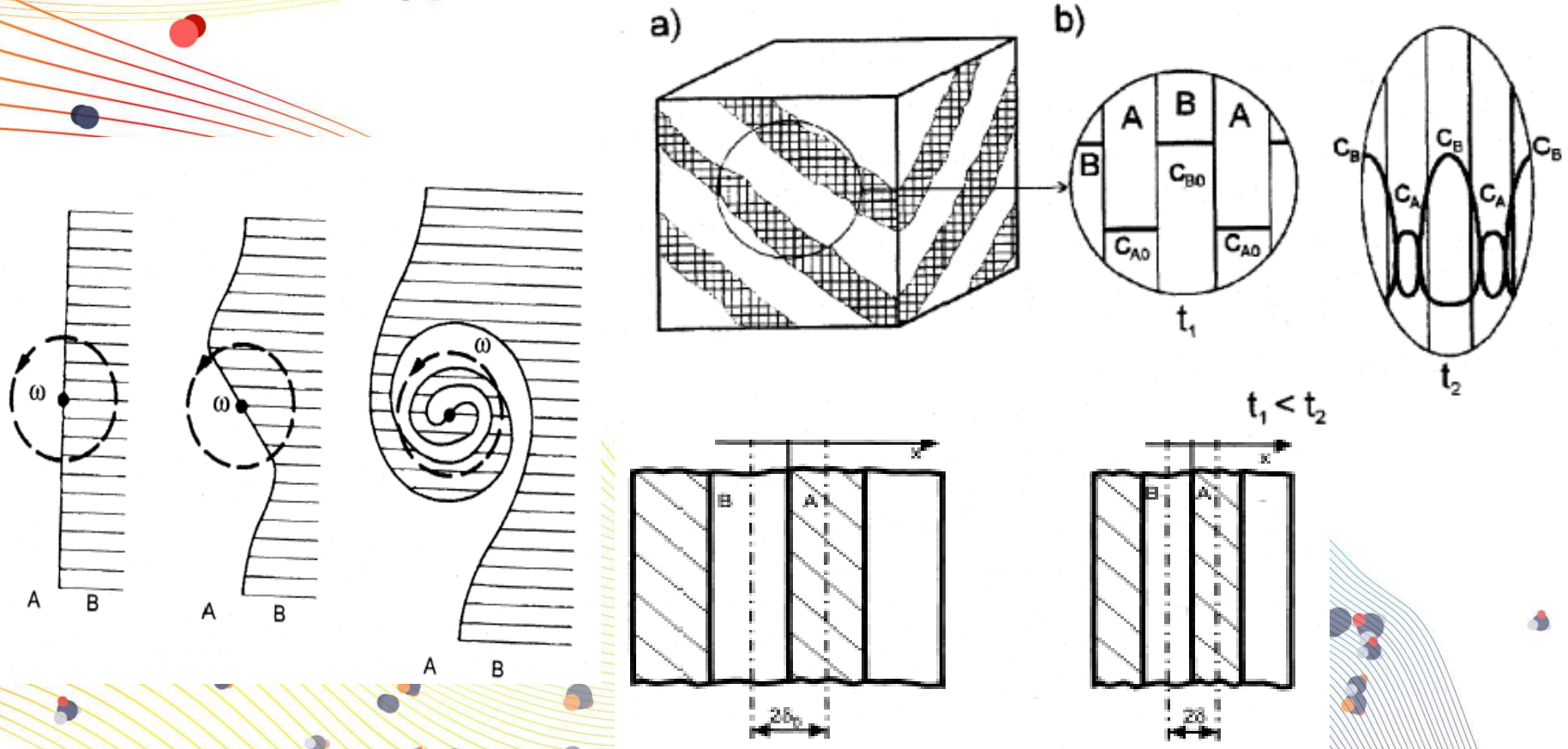
$$\tau = \frac{\nu^{1.5}}{\varepsilon^{0.5} D_m}.$$

Brief Description of Mixing Phenomena



Brief Description of Mixing Phenomena

Consider the problem of reaction and diffusion in filaments of reactants A and B



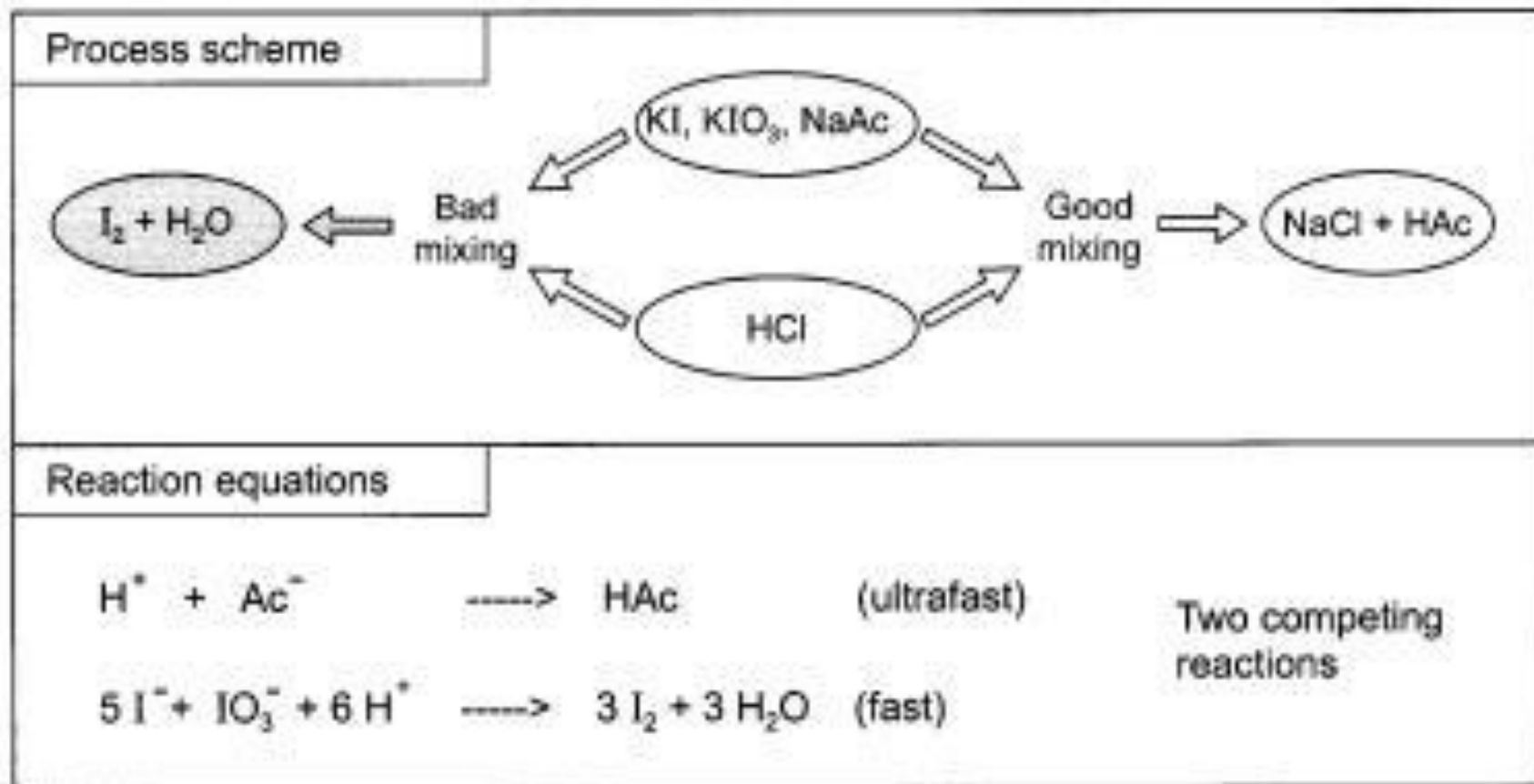
Filament Formation

Time influence and length impact

VisiMix Application

Homogeneous Reaction

Chemical Reaction



Lab experiment

Feeding HCl without stirring



Lab experiment

Feeding the HCl upper from the top



Lab experiment

Feeding the HCl close to the impeller low rpm



Lab experiment

Feeding the HCl close to the impeller high rpm



VisiMix Chem

Real-world chemical reactor dynamics

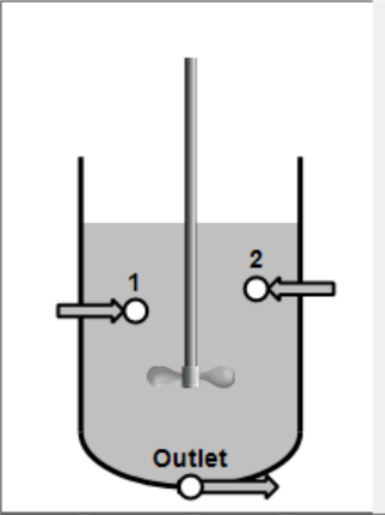


Chemical Input

Solvent, Reactants and Process Temperature

Process temperature: 26.85 °C Solvent molar mass, g/mol: 88.1 Solvent type: Organic polar (alcohol)

	Designation	Description	Molar mass, g/mol	Concentration, mol / L		
				Initial in the tank	Feed 1	Feed 2
☒	A	Reactant 1	101		2	
☒	B	Reactant 2	86			1
☒	P	Main product	101			
☒	BP1	By-product 1	86			
☒	E	Enzyme	1800	0.01		0.05
☒	C1	Intermediate 1	1900			
☒	C2	Intermediate 2	1890			
☒	BP2	By-product 2	187			



OK Cancel Print Help

Reaction Input

Chemical Reactions

Reaction List					
	Designation	Description			
☐	R1	Intermediate reaction 1 A + E <-> C1	Edit	☐	☒
☐	R2	Main Reaction C1 <-> E + P	Edit	☐	☒
☐	R3	Byproduct rereaction 1 B + E <-> C2	Edit	☐	☒
☐	R4	Byproduct 1 generation C2 <-> E + BP1	Edit	☐	☒
☐	R5	Byproduct 2 generation A + B <-> BP2	Edit	☐	☒

OK Print Help

Kinetic Reaction Input

Kinetics

Reaction Designation

R1

Reaction Description

Intermediate reaction 1

Chemical Equation

A

▼

+

E

▼

→

C1

▼

+

▼

Catalyst/inhibitor

A

▼

Forward Reaction Rate

Is this reaction catalytic, inhibited or neither one?

Catalyst ☒

Inhibitor ☐

Neither ☐

vf =

1780

*

[A]

1

*

[E]

1

*

[Catalyst]

0.1

Reverse Reaction Rate

Is this reaction catalytic, inhibited or neither one?

Catalyst ☐

Inhibitor ☒

Neither ☐

vr =

50

*

[C1]

1

/ (1 +

20

*

[Inhibitor]

0.2

)

OK

Print

Cancel

Help

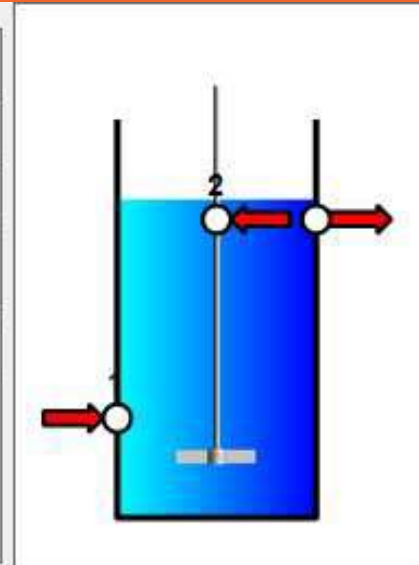
Molar concentrations were entered in mol/L.
Enter each reaction rate constant in such a unit of measure that the resulting reaction rate is expressed in mol/(L*s).
See help for more details.

Reactant List

Designation	Description
A	Reactant 1
B	Reactant 2
P	Main product
BP1	By-product 1
E	Enzyme
C1	Intermediate 1
C2	Intermediate 2
BP2	By-product 2

Process Operation Input

CP—Flow Rates and Transient Process Duration	
Feed 1 Flow Rate	100.0 L/min
Feed 2 Flow Rate	100.0 L/min
Note Product Stream Flow Rate = 200.0 L/min (Feed 1 + 2 Flow Rates)	
Transient Process Duration	1200.0 s
OK Cancel Print Help	



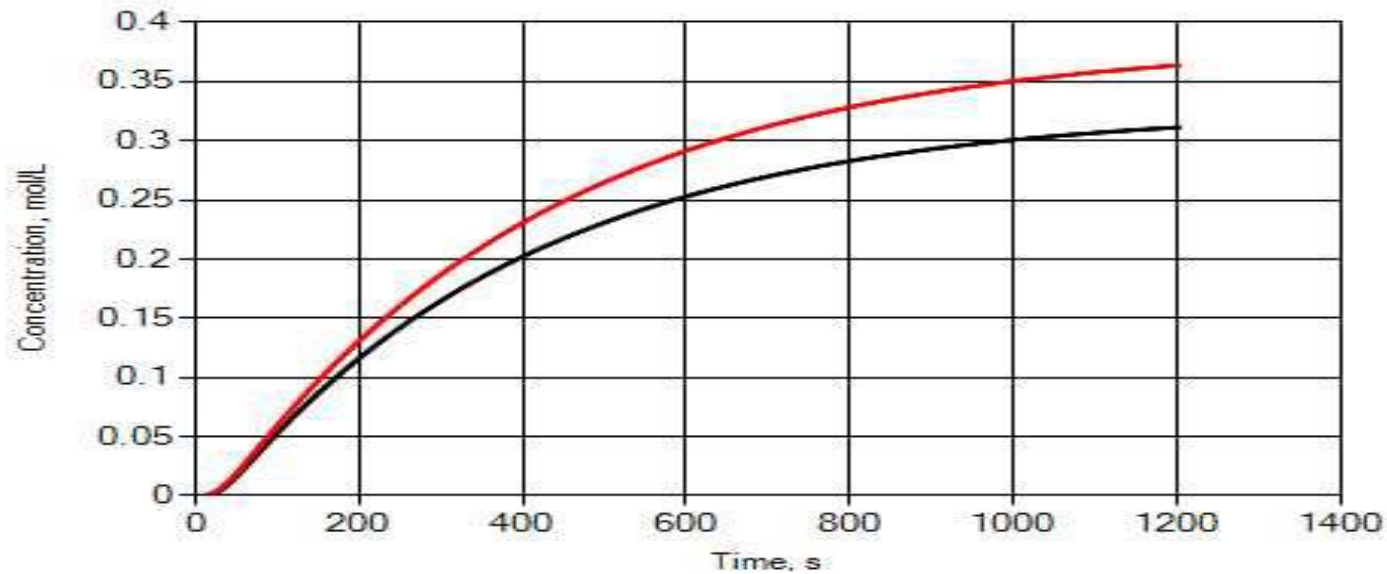
Inlet and Outlet Locations	
INLET 1	
Radius	0 mm
Height	1500 mm
INLET 2	
Radius	500 mm
Height	450 mm
OUTLET	
Radius	0 mm
Height	0 mm
OK Cancel Print Help	

A schematic diagram of a stirred tank reactor showing the locations of the inlet and outlet ports. The tank is filled with a blue liquid. Inlet 1 is located at the top center of the tank. Inlet 2 is located on the right side of the tank, 2001 mm from the bottom. The outlet is located at the bottom center of the tank, 1000 mm from the left side. The diagram includes dimension lines indicating these distances.

Reactions Results Screen

Continuous Flow Process—Concentration over Transient Period

Reactant P Concentration in Product Stream



— Reactor with Perfect Macromixing

— Actual Reactor

	Reactant Designation	Actual Reactor—Tank	Actual Reactor—Product Stream	Reactor with Perfect Macromixing
▶	A	0.06117	0.02273	0.02665
	B	0.04054	0.09427	0.07044
	P	0.3136	0.3114	0.3638
	BP	0.07411	0.07071	0.04379

Examples

1. Batch Reaction: Impeller rpm influence

esterification in acidic homogeneous conditions

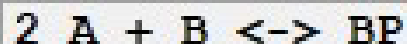


2. Continuous Reaction: Feeding Position for Multiple reaction. Baffle Effect.

Main reaction



By-product reaction



Examples

3. Continuous Reaction: Multistep Impellers in the shaft:

Main reaction



By-product reaction

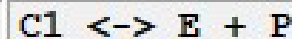


4. Continuous Reaction: Enzyme Reaction

Intermediate reaction 1



Main Reaction



Byproduct reaction 1



Byproduct 1 generation



Byproduct 2 generation



VisiMix Products



VisiMix Turbulent

Low viscosity liquids and multi-phase system



VisiMix DI

Combined mixing devices



VisiMix Laminar

Highly viscous and non-Newtonian



VisiMix RSDE

Rotor Stator Disperser and/or Emulsifier



VisiMix Pipeline

Carreau rheological model



VisiXcel

Creating an organized data base



Bubble columns

simulations with bubble mixing



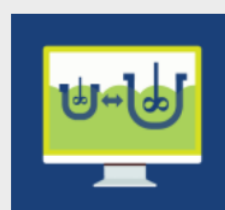
VisiMix 3D Viewer

3-dimensional visualization



VisiMix Off-Center

modeling and technical calculations



Scaling Up/ Down

SCALING up/down efforts



Process Evaluation

performance of mixing operations



VisiMix Chem



Sensitivity Analysis

VisiMix Orientation



The VisiMix Demonstration Tools:

- ✓ VisiMix Turbulent – Examples & User Guide
- ✓ VisiMix Laminar - Examples & User Guide
- ✓ VisiMix Different Impellers – Examples & User Guide
- ✓ VisiMix RSDE– Examples & User Guide
- ✓ VisiMix Turbulent SV – Trial & Education
- ✓ VisiMix Review of Mathematical Models
- ✓ Selected Verification Examples

*The Comparison between Published Experimental Data and
VisiMix Calculations*

<http://www.visimix.com>

Millions Saved By Using VisiMix!

Benefit Examples Reported by Customers.

VisiMix LTD, is pleased to provide you with some very important new information on VisiMix Savings, which we have compiled for publication. These documents, show **savings of millions of dollars per year**. Please click the links directly below to view the following savings examples:

[Mixing Calculations in Development](#) (Saved - \$1,000,000)
[Productivity Improvement In API Company](#) (Saved - \$1,600,000)
[RSD Application in a Chemical Reaction Process](#) (Saved - \$250,000)
[Control Morphology and P.S. in Energetic Material Processes](#) (Saved - \$900,000)
[Troubleshooting for Crystallization Processes](#) (Saved \$2,000,000)
[Troubleshooting in Life Science Industry](#) (Saved €900,000)
[Three Phase System – Solid-Liquid-Liquid](#) (Saved €1,200,000)
[Improve Dissolution of Organic Solid](#) (Saved €1,200,000)
[Physical Properties of the Final Product \(Solid\) – Ensuring Regulatory Compliance of \\$20,000,000 Sales](#)

We also invite you to view some highlights from our very successful **forum** which united users and future users of the VisiMix Software to share some insights into the various uses and benefits of the software.

Conclusion

- **Using VisiMix Products support you can**
 - **understand better your processes**
 - **Reduce dramatically your Scaling up processes and Scaling down**
 - **Save a huge amount of Time & Money (\$1,000,000 +)**
- **The VisiMix Products are friendly and easy to use with very quick results.**
- **The VisiMix results are based on a systematic and seriously experimental checking – and found very reliable.**
- **VisiMix Projects Parameters and Data Base allows you to share and transfer the data with colleagues in the company.**



Thank You

For your attention

VisiMix Ltd.

PO Box 45170, Jerusalem, 91450, Israel
Tel: 972 - 2 - 5870123 | Fax: 972 - 2 - 5870206
E-mail: info@visimix.com



The background of the slide is a complex, abstract design. It features numerous thin, wavy lines in shades of yellow, orange, and light blue that flow across the frame. Scattered throughout these lines are many small, semi-transparent spheres in various colors, including red, blue, grey, and orange. The overall effect is one of dynamic movement and data visualization.

More about VisiMix Applications

Motivation

Common Questions

- ✓ Did we cover the main parameters during the process development?
- ✓ Will our facilities will be appropriate for the developed process?
- ✓ Does the equipment offer is good for the process?
- ✓ What about safety and runaway scenario?
- ✓ Do our process is robust?
- ✓ Does the operational range parameters are large enough for the manufacture facilities?

The Goal

Once the Science of the process (Chemistry, Biology or physics) is known well, a common situation during the process transfer from lab to production or from site to site is the gap between the old and new results.



Our first goal is to develop a process that will run properly in the first trial on a new scale or site, similar to our successful results in the lab or in the old facility.

To achieve this, we need to evaluate the process with the same conditions we will have in the production phase.



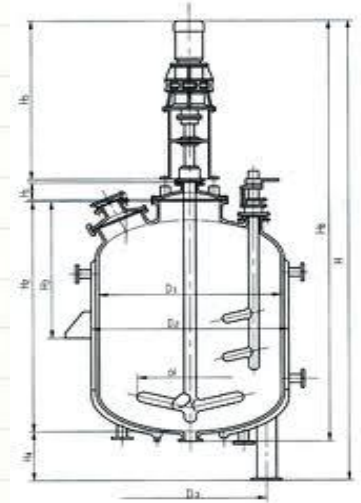
The main parameters we change are the hydrodynamics of the system. If we can identify and control these parameters, we will be able to achieve to the available and optimal solution.

Data and Results Management



R&D

Design

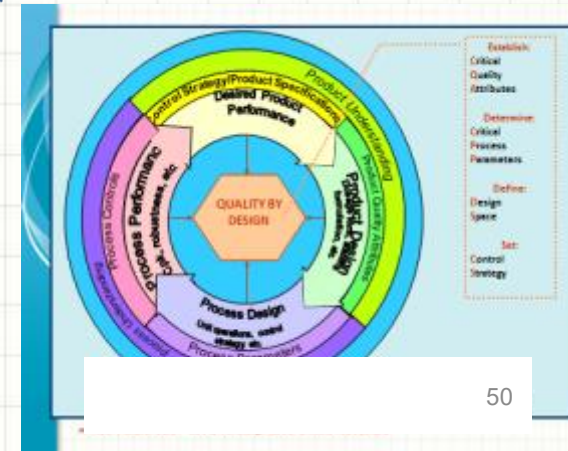


VisiMix

Mixing Simulation Software

Production

QbD



What is Good Mixing?

Troubleshooting in Life Science Industry

Savings of 900,000 Euro!

VISIMIX SOLUTIONS



TURBULENT[®]
2Kx

Low viscosity
liquids and
multi-phase
system

Process: *Trouble shooting in Life Science Industry after break down of equipment*

Task: *Understand reason for failed batches and establish new operation conditions with the new equipment.*

The Process

Chemical reaction on porous beads in the life science industry.

The Problem

One product is produced in three slightly different reactors. An intermig impeller was installed in one of the reactors after a breakdown. The flow properties were much higher for batches from the reactor with the new impeller and several batches were out of specification. It was known that oxygen hydrolysis destroys the sugar molecules while the slurry is basic.

The Traditional Approach

Trial and error in the production facilities in order to do "fine tuning" of the operational parameters in the process. No improvement was observed.

The VisiMix Analysis

VisiMix was used to find out why the process failed and make suggestions to remedy the challenge.

The VisiMix Solution

Due to the design of the old impeller, all beads were found in the lower part of the reactor. VisiMix calculations showed that the improved mixing accelerated hydrolysis. VisiMix also showed that the new impeller was not suited for the process and that the only way to avoid failed batches was to stop using the vessel for this product.

The Results

Oxygen hydrolysis during basic conditions destroys the sugar molecules. Concentration of product much higher below the old impeller. Due to the improved mixing hydrolysis was accelerated.

“From the outcome of this case, we understood that the combination of the company knowledge of the process with VisiMix simulation is more than must – in order to succeed to define new equipment for new processes.”

“The Launch was delayed by 6 months and the potential of production during this months is – 1,200,000 Eu and there are some more expenses connected with purchasing equipment”

Technical Description

Process :

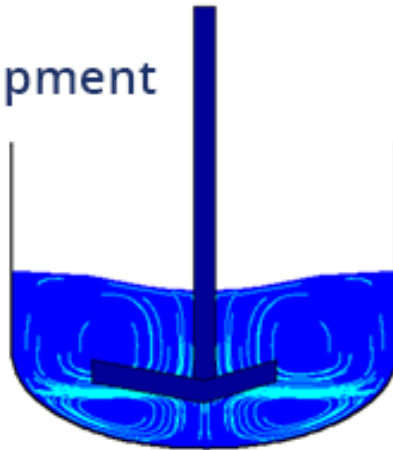
Troubleshooting in the life science industry after breakdown and repair of equipment

Task :

Understand the reason for failed batches and establish new operation conditions with the new equipment.

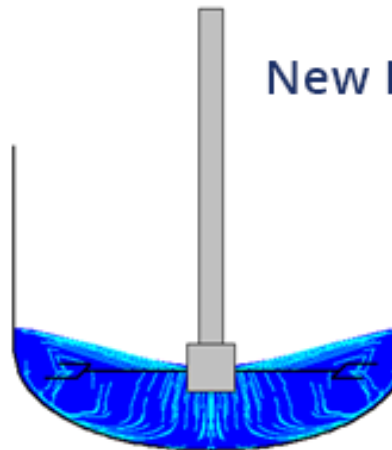
Previous Equipment

R333
Di=1700 mm
3 blade



New Equipment

R331
Di=2100 mm
Intermig



		R333	R331
Mixing Power	W	5,51	48
Reynolds number for flow		1180000	2470000
Average value of tangential velocity	m/s	0,575	0,962
Circulation flowrate	m3/s	0,0502	0,298
Average circulation velocity	m/s	0,021	0,155
Mean period of circulation	s	27,9	4,7
Vortex depth	m	0,085	0,205

Improved mixing accelerated hydrolysis. VisiMix showed that the impeller was not suited for this process, and as a result the production was moved to reactors with appropriate mixing.

Proposed Method

Mixing Calculations in Development

Save with VisiMix (for this example: \$1,000,000 per project)!

VISIMIX SOLUTIONS



Process:

Typical Fine Chemical Development

Task:

Decreasing the Number of required batches for Validation Process in the production step.

The Process

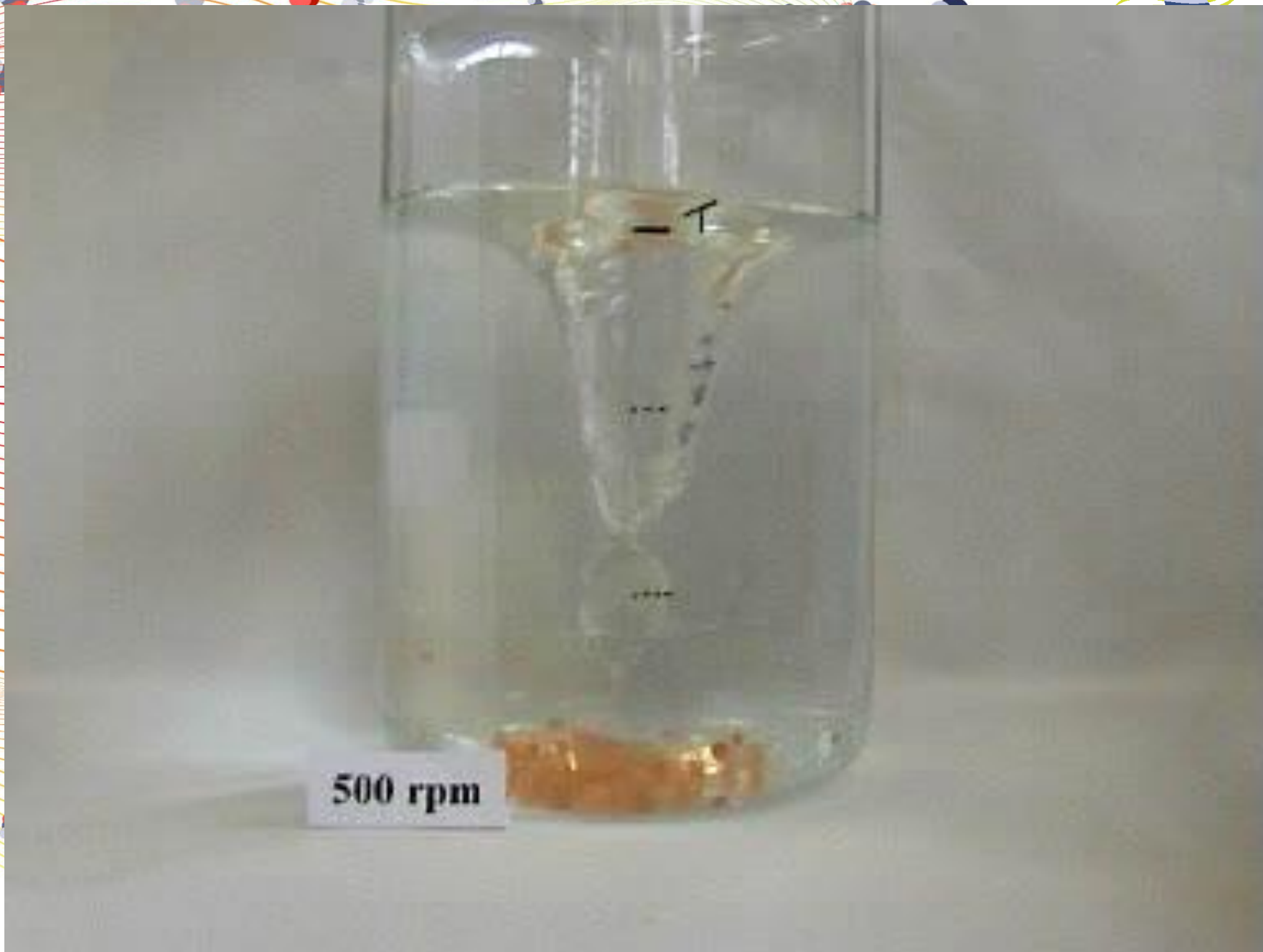
Batch and Semi batch Process.

The Problem

Gap between R&D and production results.

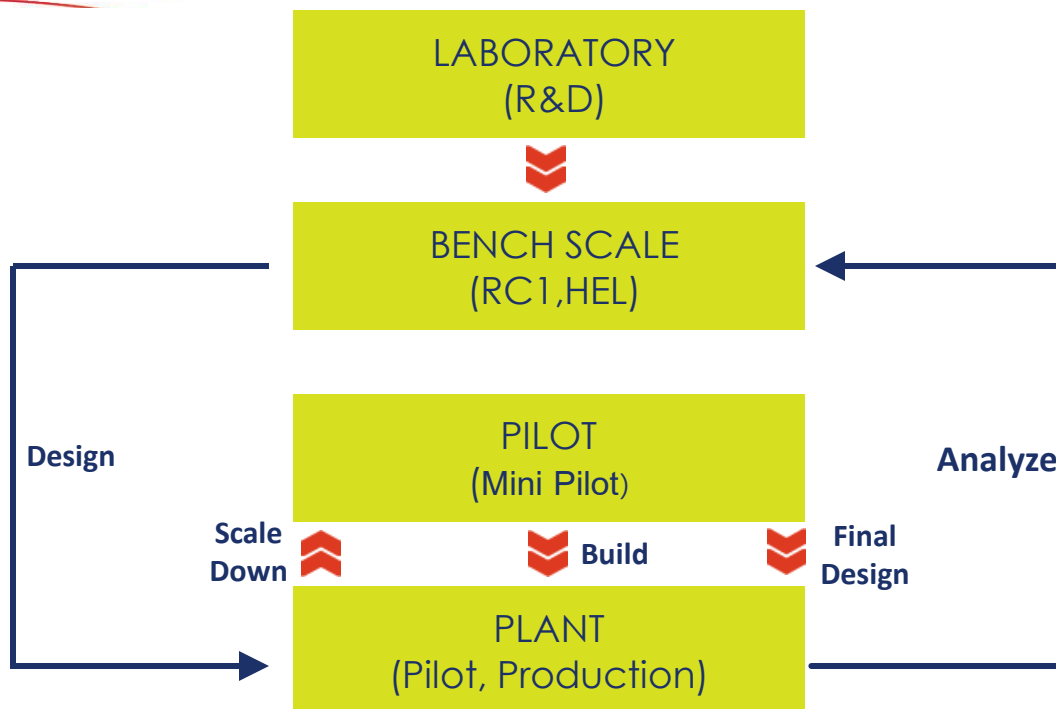
The Traditional Approach

Running the process at increasing sized reactors and looking for optimal process and operation parameters at every stage.

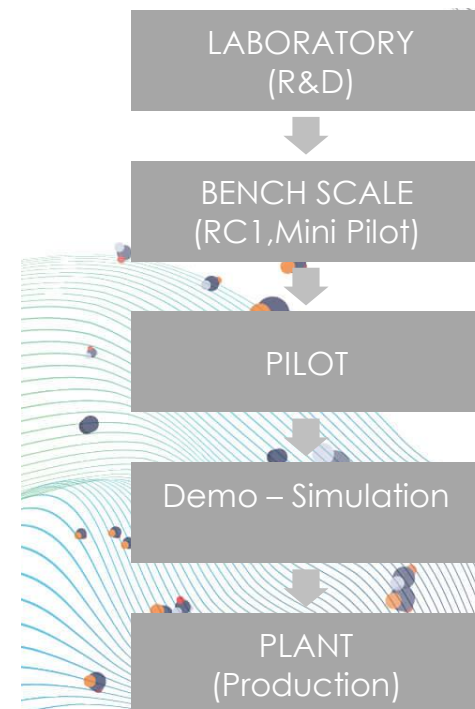


Methodology

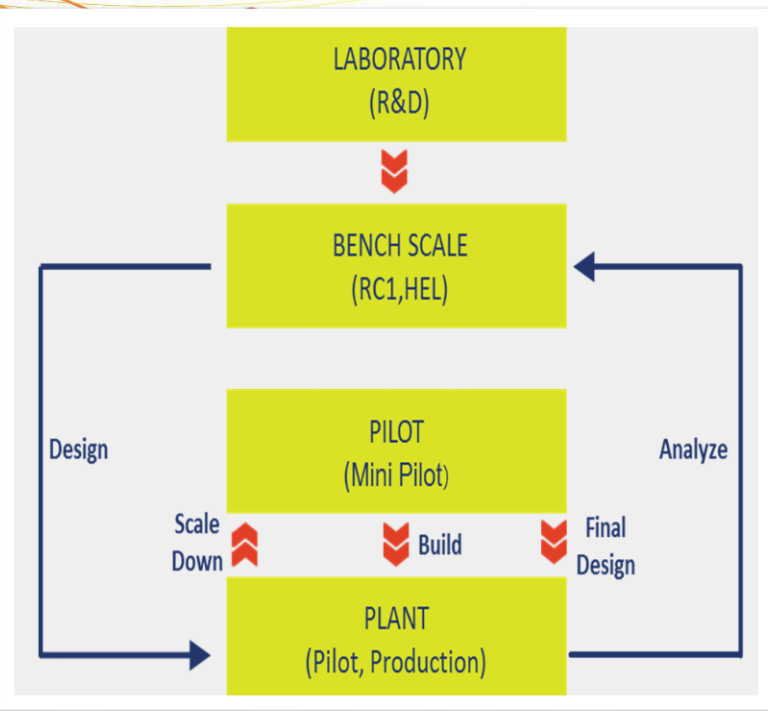
New Process with Mixing



(J.M. Berty, CEP, 1979)



Methodology



- » **Step 1:** Know the Mechanism of your Process.
- » **Step 2:** Calculate Mixing Parameters will be available to provide in the commercial stage equipment.
- » **Step 3:** Set Up Lab or Pilot equipment at the same range of work as calculated in Step 2.
- » **Step 4:** Run Statistical Design of Experiments under conditions Set Up in Step 3 and select relevant experiments to proof the mechanism and achieved a good product quality, effective process operation and maximum yield.
- » **Step 5:** Model Verification by Scaling down in industrial equipment for sample customer product.
- » **Step 6:** Generate a Final Design, Procedure an Operation.

Lab and Prod Calculations

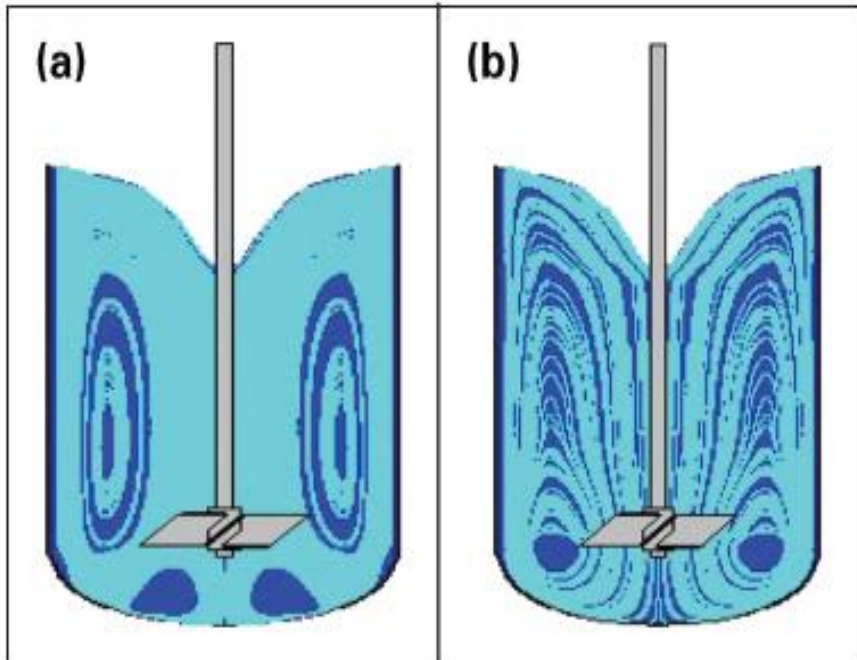


Figure 1. RC-1 General flow – pattern picture, (a) pumping down and (b) pumping up.

Operational Parameter	R 7610	R 7501 Modified
Operation Initial Conditions		
Reactor Volume, L	8	100
Reactor Temperature, °C	70	70
Stirrer Velocity, rpm	450	300
Hydrodynamics		
Mixing Power, W	17	335
Reynolds for Flow	73200	249000
Turbulence Main Characteristics		
Energy Dissipation – Average value, W/kg	2.29	3.61
Energy Dissipation – Maximum Value, W/kg	103	122
Liquid-Solid Mixing Main Characteristics		
Solid Suspended Condition is Expected	OK	OK
Maximum Degree of Non-Uniformity – Axial, %	14	15
Maximum Degree of Non-Uniformity – Radial, %	5	4
Average Concentration of Solid Phase in Continuous Flow, kg/m ³	39	39
Gassing Characterization		
Gas Hold – Up*	0.00024	0.16
Specific Mass Transfer Coefficient Gas – Liquid, 1/s	0.0015	0.655
Gas Mass Transfer Rate*, kg/h	0.0011	6.84
Gas Distribution: Satisfactory, Flooding Not Expected	OK	OK
* Gas Hold-up: represents the average value of volume fraction of gas in the gas-liquid mixture. * Gas Mass Transfer Rate: rate of gas dissolution corresponding to specific mass transfer coefficient.		

Non-Ideal Stirring – Non homogeneity

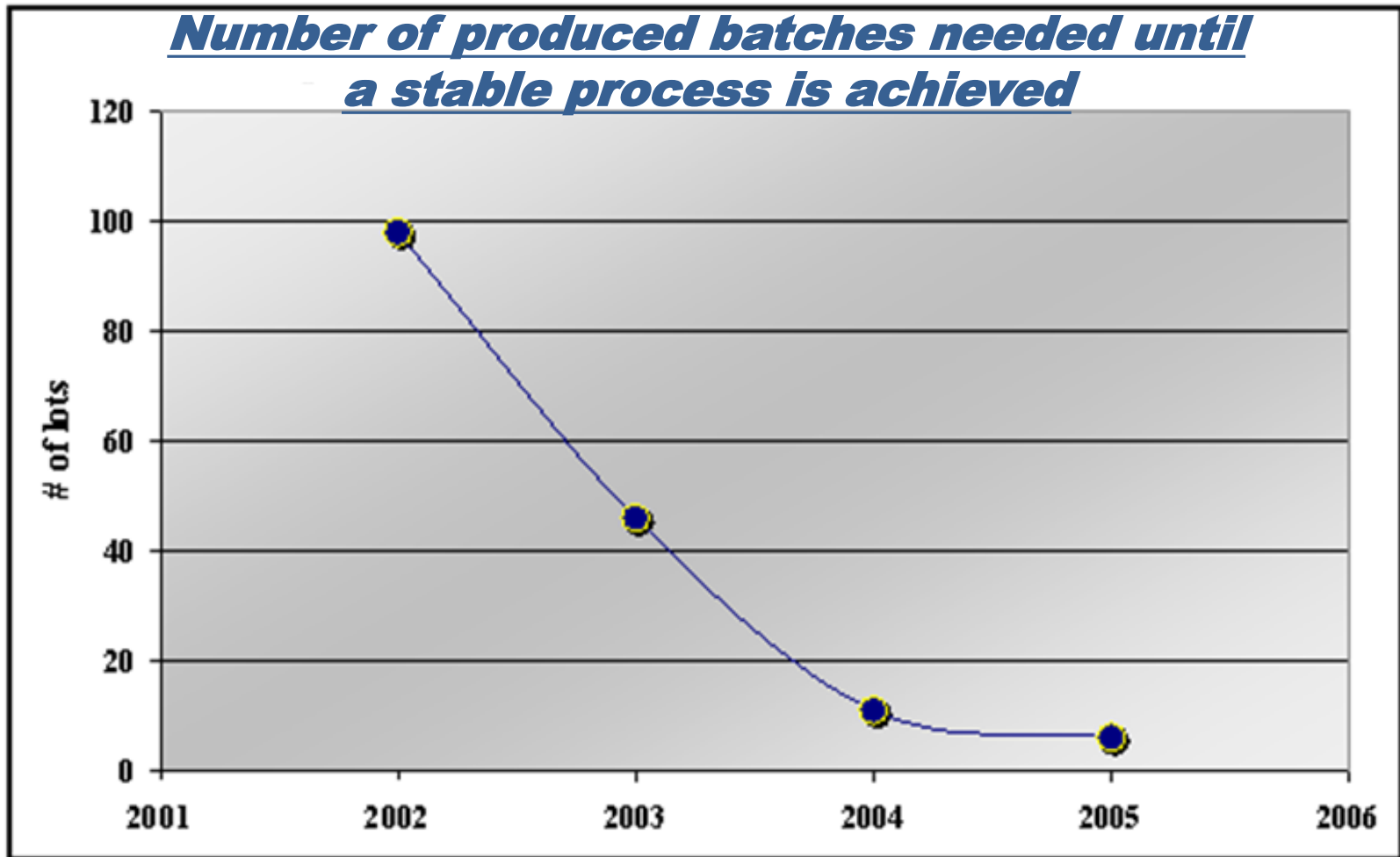
Before performance of scale up experiments **VisiMix** simulation was used to check suspension at different Mini Pilot Reactors:

Reactor	7603	7605	7605	7607
Volume, L	10	25	25	50
RPM	500 (Max)	400	500 (Max)	150 (Max)
Liquid – Solid Mixing				
Solid suspension quality	Complete suspension is questionable. Partial settling of solid phase may occur.	Complete suspension is expected.	Complete suspension is expected.	Complete suspension is questionable. Partial settling of solid phase may occur.
Max. degree of non uniformity of solid distribution				
AXIAL, %	22.3	10.3	29.1	132
RADIAL, %	65.7	34.3	76.3	90.8

Not all Mini Pilot reactor are capable of full suspension of Reagent

Methodology

**Number of produced batches needed until
a stable process is achieved**



VisiMix Application

Crystallization

Mixing Parameters for Crystallization Processes

IMPORTANT PARAMETERS	ANSWERED QUESTIONS AND NOTES
Axial and radial solids uniformity (distribution)	What is the uniformity throughout the vessel? Ensure that solids do not accumulate on the bottom.
Micromixing time	How long is the micro scale degradation of non-homogenized concentration? This is important for precipitations.
Energy of collisions in bulk	What is the collision energy of particles? A high number of collisions in the bulk can affect breakage and secondary nucleation.
Collisions of maximum energy	How often do the slurry particles see the maximum collision energy? What is the frequency near the zone of maximum turbulence near the impeller blades? Frequent collisions lead to more breakage and secondary nucleation.
Local values of energy dissipation	What is the average energy dissipation in the agitator zone? What is in the bulk slurry? What is it at the baffles? Dissipation controls breakage, nucleation and micromixing in these zones.
Maximum energy dissipation	Manipulating energy dissipation in the area behind the agitator blades controls breakage, nucleation and micromixing in this zone.
Time between strong collisions	What is the average period of uninterrupted crystal growth?
Shear rates	What is the likelihood of rupturing the crystal or agglomerates? What is the impact on growth and desolution for the agitation conditions?

Mixing Parameters for Crystallization Processes

Cooling crystallization of API in 6000 liter reactor.

Campaign	$X(v, 90) < 250 \mu\text{m}$
First	195
Second	325

After investigation it was found that the tip diameter of the Agitator was damaged, and the real diameter is a 80 % of the reported one.

ENERGY DISSIPATION - MAXIMUM VALUE

Parameter name	Units	Value
Energy dissipation - maximum value	W/kg	191

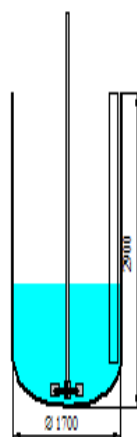
For HELP press F1

ENERGY DISSIPATION - MAXIMUM VALUE

Parameter name	Units	Value
Energy dissipation - maximum value	W/kg	115

For HELP press F1

[VisiMix_R3107] - Drawing of apparatus



For HELP press F1

[VisiMix_R3107-new] - Drawing of apparatus



Volume 

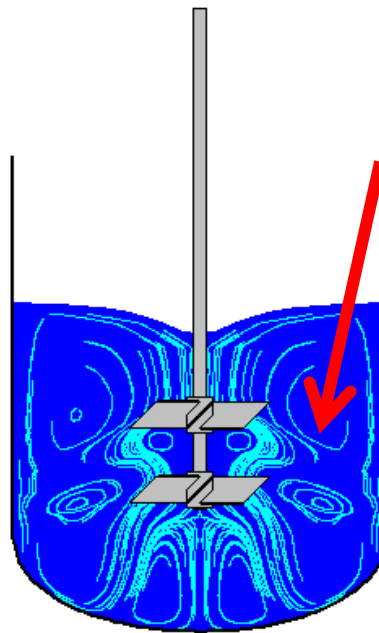
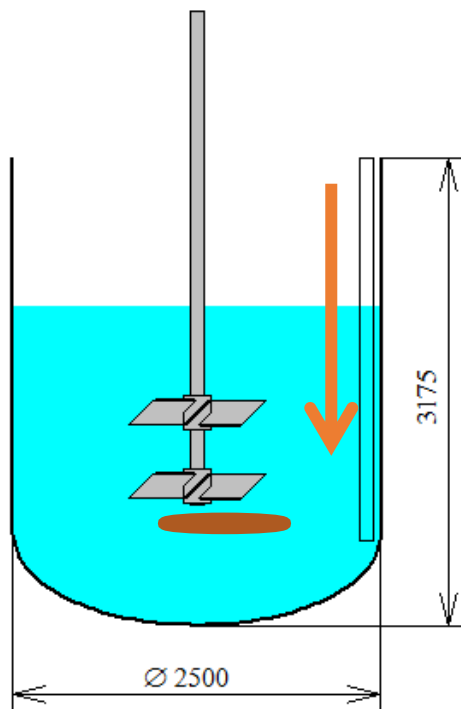
For HELP press F1

VisiMix Application

Gas Liquid Reaction

Description

- Gas – Liquid reaction in pilot scale ~ 1000 liter is finished after 4 Hour
- Same in Production 4 Days.



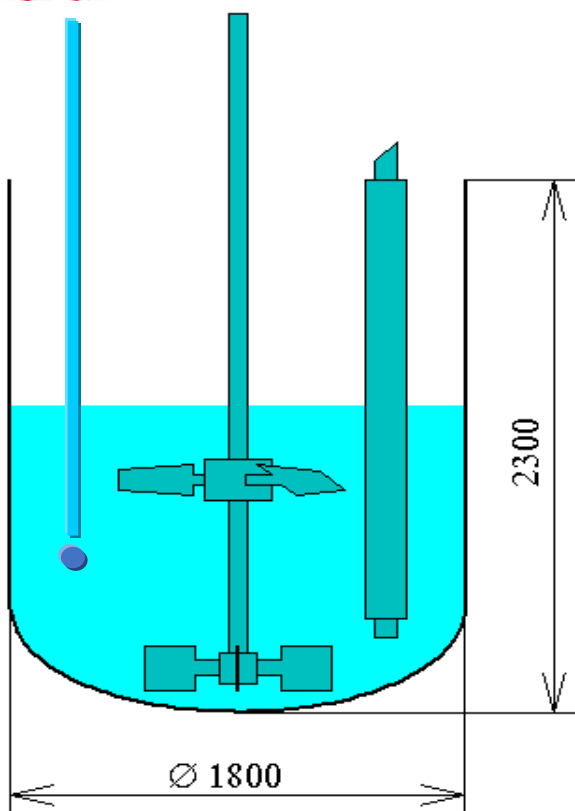
After Change
Position the
process take
around **14 hours**

VisiMix Application

High Shear Rate in Semi Batch Homogeneous Reaction

Process and Quality Problem

Feed R-Cl



Process



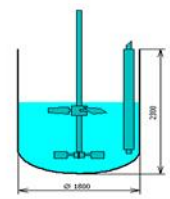
Impurity



R-6826

Impurity Results at Laboratory and Production

[%]impurity	RPM	Impeller type	system
0%	15,000 rpm	rotor stator	Laboratory reactor
0.3%	1,500 rpm	3-blade	
0.6%	800 rpm		
1.5%	100 rpm		
0.3% - 0.6%	140 rpm	bottom – flat blade up - turbofoil	R-6826



R-6826



Rotor stator



Lab impeller

Working with Rotor Stator at Laboratory Scale

Problem

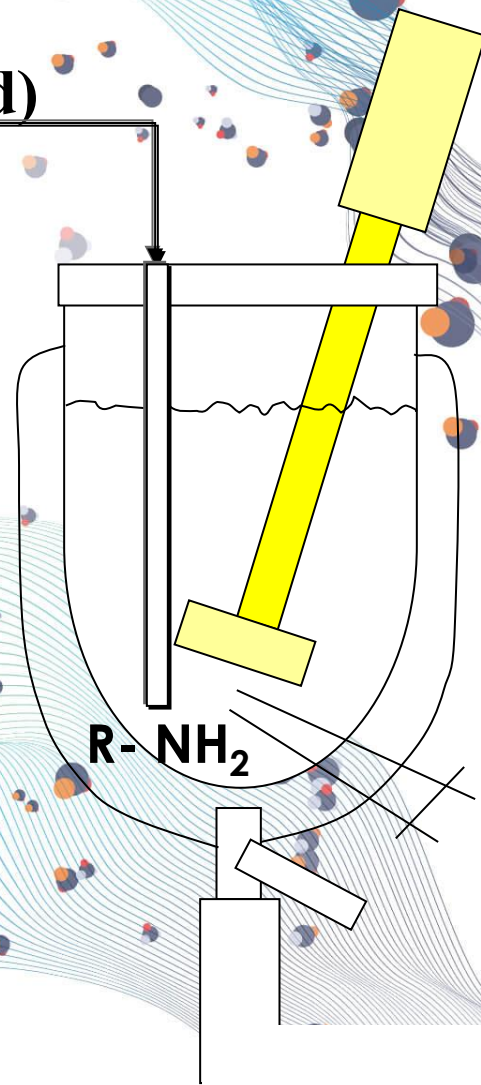
How to scale up ?

Potential Saving :

**MORE than 250
K\$**

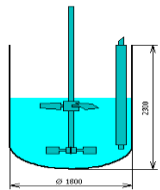


R'-Cl (liquid)

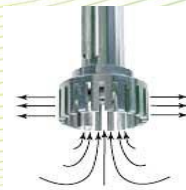


Calculating Shear Forces with VisiMix

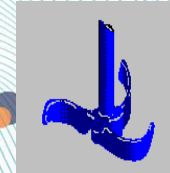
Turbulent shear rate [1/s]	[%]impurity	RPM	Impeller type	system
780,000	0%	15,000 rpm	rotor stator	Laboratory reactor
32,900	0.3%	1,500 rpm	3-blade	
12,900	0.6%	800 rpm		
580	1.5%	100 rpm		
15,200	0.3% - 0.6%	140 rpm	bottom – flat blade up - turbofoil	R-6826



R-6826



Rotor stator



Lab impeller

VisiMix Products



VisiMix Turbulent

Low viscosity liquids
and multi- phase
system



VisiMix DI

Combined mixing
devices



VisiMix Laminar

Highly viscous and
non- Newtonian



VisiMix RSDE

Rotor Stator Disperser
and/or Emulsifier



VisiMix Pipeline

Carreau rheological
model



VisiXcel

Creating an organized
data base



Bubble columns

simulations with bubble
mixing



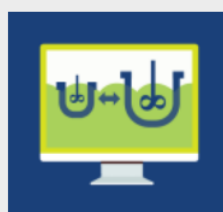
VisiMix 3D Viewer

3-dimensional
visualization



VisiMix Off-Center

modeling and
technical calculations



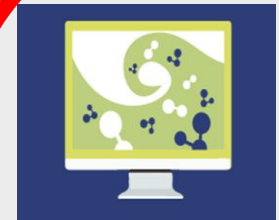
Scaling Up/ Down

SCALING up/down efforts



Process Evaluation

performance of mixing
operations



VisiMix Chem

VisiMix Products

VisiMix 2K8 Turbulent – for **low-viscosity** liquids and multiphase systems.

The program provides process parameters necessary for analysis, scaling-up and optimization of mixing tanks and reactors with all types of impellers

Calculations of:

- ✓ Blending
- ✓ Suspension
- ✓ Dissolution
- ✓ Emulsification
- ✓ Gas dispersion
- ✓ Heat transfer
- ✓ Chemical reactions
- ✓ Mechanical stability of shafts



VisiMix Products

VisiMix *2K8 Laminar* - for highly viscous media

- ✓ Newtonian and non-Newtonian
- ✓ Macro-scale blending
- ✓ Micromixing in high-shear areas
- ✓ Heat transfer
- pastes
- creams
- shampoos
- liquid soaps
- gels
- ointments
- paints:
- coatings
- slurries
- polymer solutions



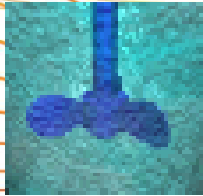
VisiMix Products

VisiMix 2K8 *Different Impellers* – for combined mixing devices



- The program handles mixing devices consisting of any 2 – 5 impellers.
- Different distances between impellers
- Used in combination with VisiMix Turbulent.
- Provides parameters of hydrodynamics, turbulence and heat transfer.

VisiMix Products



VisiMix VisiXcel – Data Base (DB) – automatic conversion tool:
Visimix Output to Excel Spreadsheet

- ✓ Integrates VisiMix report parameters in standard Excel worksheets
- ✓ Analysis VisiMix results in Excel
- ✓ Builds a Database of mixing tanks and reactors.
- ✓ Builds a Database of projects - for processes
- ✓ Makes correlation between plant equipment nomenclature to VisiMix database of mixing tanks and reactors in VisiMix Project Database.
- ✓ Easy access to design data of the mixing tanks, to process parameters and to corresponding results of VisiMix modelling.
- ✓ Results of VisiMix mathematical modelling in the **VisiMix VisiXcel-DB** and arrange the data according to the reactor nomenclature.
- ✓ Easy access to recalculation of the VisiMix modelling from the Database of the reactors & the projects

VisiMix Products

VisiMix Pipe-Line

- 
- ✓ Calculates hydraulic resistance of simple pipelines for liquid viscosity and non-Newtonian products.
 - ✓ *Chemical engineers benefit from a quick and user-friendly method for charging times and the bottle-necks in the line.*
 - ✓ **Includes :** - Pipes - Riffled hoses – Elbows – Valves - And more
 - ✓ Also comes with a **database containing rheological constants** for the typical commercial non-Newtonian products - pastes, creams, shampoos, paints, etc. (**see Help Section for details**)
 - ✓ *The **first and only tool** calculating flow resistance for liquids that correspond to **Carreau rheological model**. (See Help Section for details)*

VisiMix Products

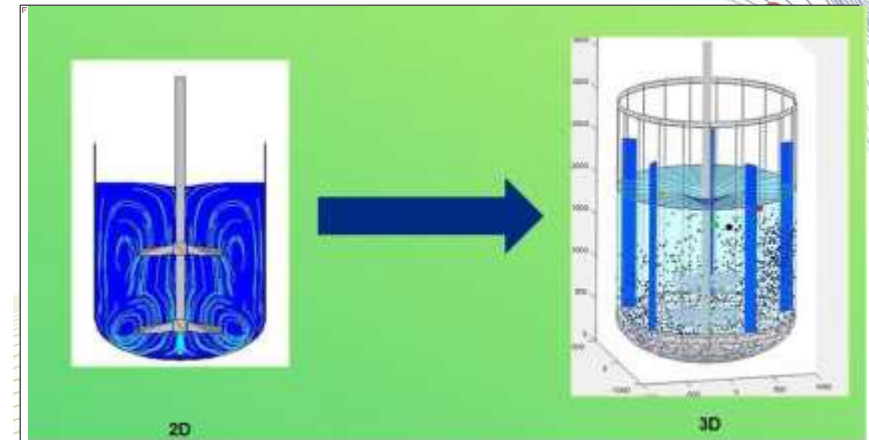


VisiMix RSDE (Rotor Stator Disperser Emulsification)

- ✓ The revolutionary new VisiMix RSDE - Rotor Stator Disperser Emulsification software is the first product of its kind that provides support for mixing devices for media subjected to high shear stress: *Based on 3 years dedicated research in a lab with dedicated equipment*
Works with all types of media - both high and low viscosity liquids, Newtonian and Non-Newtonian.
- ✓ Input geometrical data and process parameters and obtain fast and reliable results with one click
- ✓ VisiMix RSDE enables you to quickly calculate
Shear rates and stresses in internal spaces
Pumping capacities
Power consumption and torque

3D Visualization of Mixing, Based on the Hydrodynamic Model of the Flow Pattern.

- ✓ This is an exciting 3D visualization based on the VisiMix calculations
- ✓ Grasp the VisiMix results much better.
- ✓ The VisiMix process now looks alive.
- ✓ It is much easier to understand and explain VisiMix results to others and to management.



Alternative Impellers

- ✓ Now anyone from your professional can use VisiMix for the entire range of impeller geometries and can now be studied for **known power and flow numbers**.

ALTERNATIVE IMPELLER. SCHEME IS SYMBOLIC.

Tip diameter (D)

mm

Number of blades

INPUT OPTIONS

Np - Power Number &
Nq - Circulation Flow Number

Np - Power Number &
Tip Pitch Angle of Blades



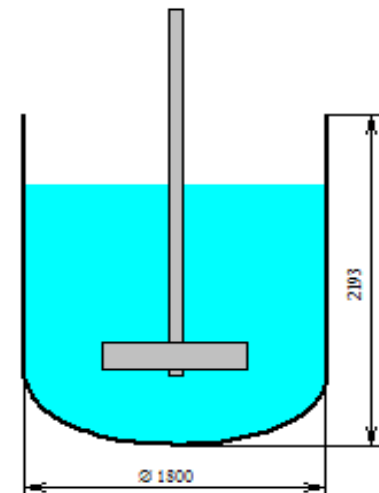
Power number Np

Circulation flow number Nq

Tip pitch angle of blades

Np and Nq - values based on experimental measurements in water in a fully baffled tank with $H/T = 1$ and $T/D = 3$.

Here T - tank diameter, H - level of liquid, D - tip diameter of impeller.



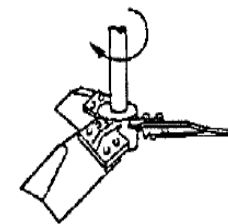
Hydrofoil Impellers

A New Option of Selecting Hydrofoil Impellers from Different Manufacturers

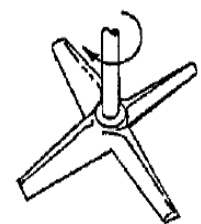
- ✓ Provide streamlined flow as compared to axial imp's
- ✓ Give low shear but more uniform velocity
- ✓ Results in lower power consumption
- ✓ Used mainly for blending of miscible liquids, suspensions of solids and gas-liquid, liquid-liquid mixing



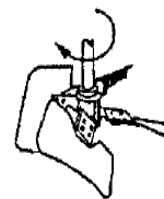
Lightnin A310



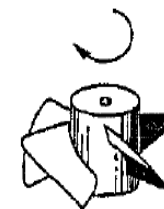
Chemineer HE3



EMI Rotofoil



Lightnin A315



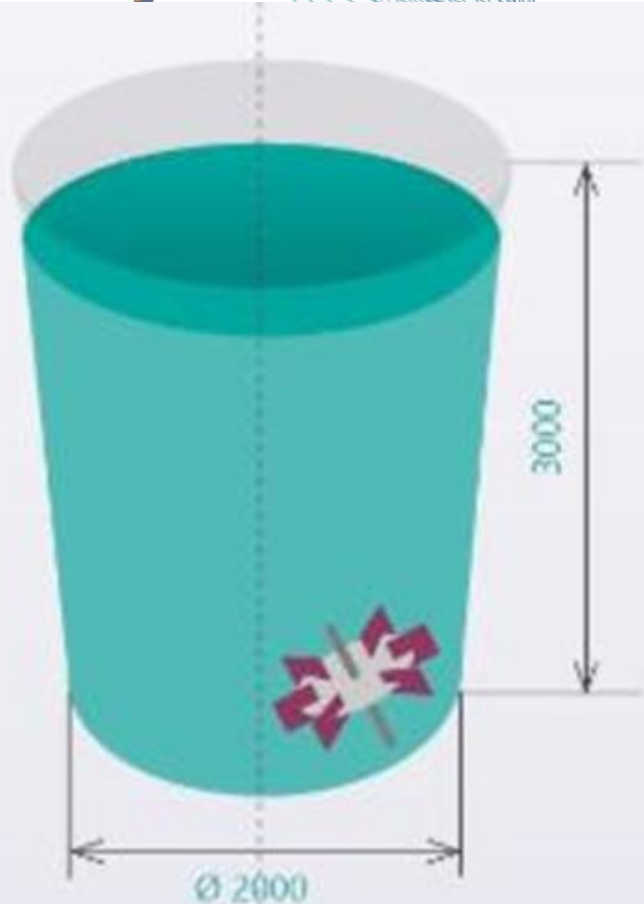
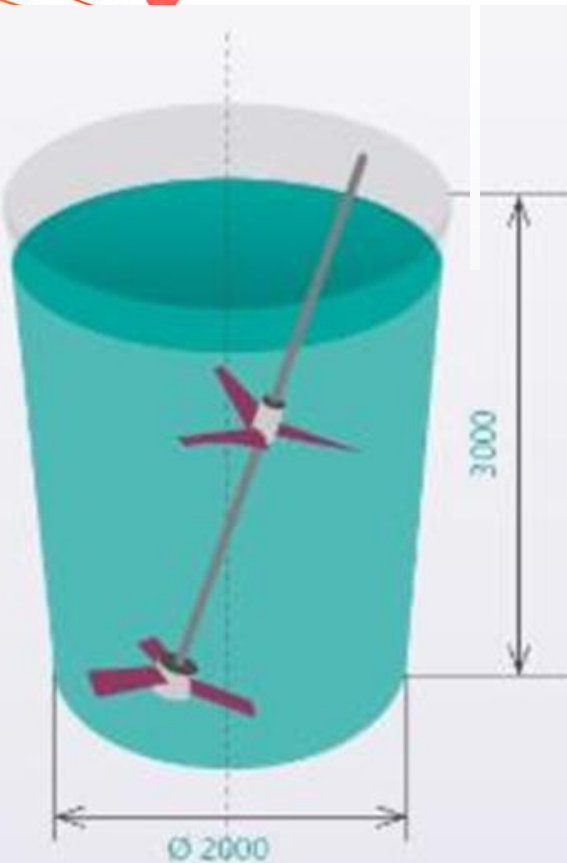
Prochem Maxflo



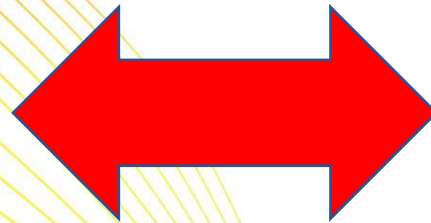
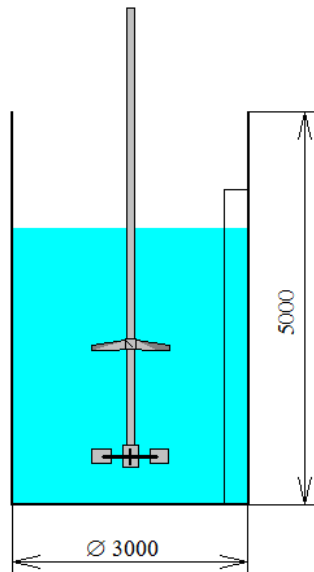
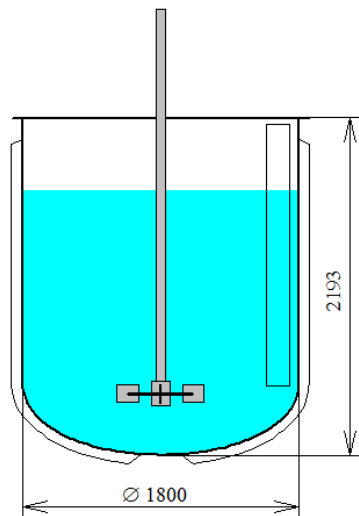
Ekato INTERPROP

VisiMix Off Center Impellers

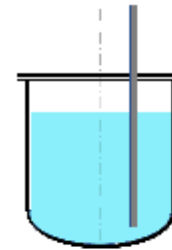
VisiMix



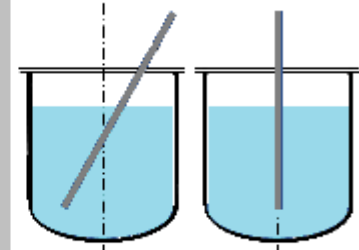
Off Center Impeller Options



SCHEME TYPES

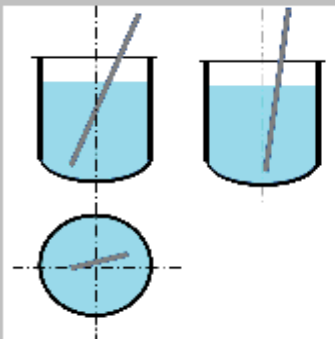


Off-center vertical shaft

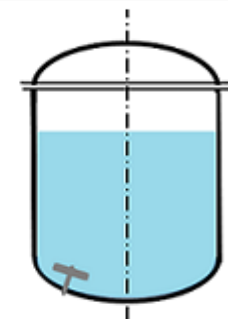


Shaft inclined in one plane

FOR ELLIPTICAL BOTTOM ONLY!
For flat/conic bottom select another scheme.



Shaft inclined in two planes

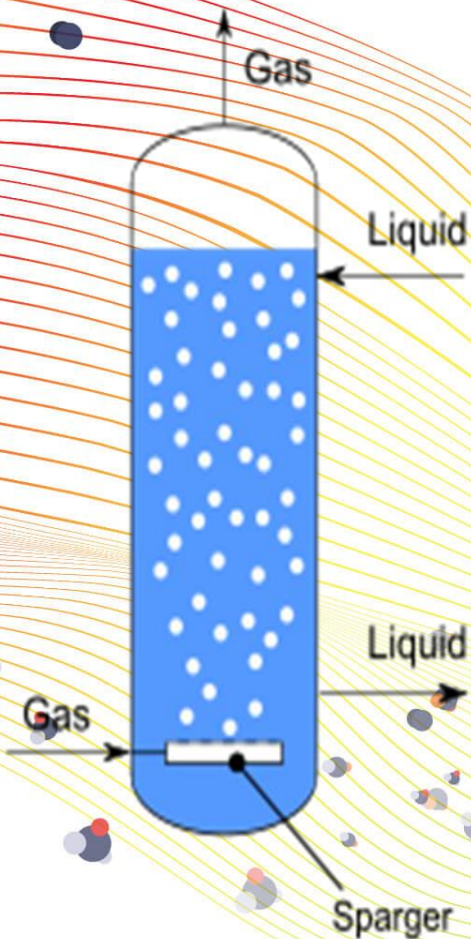


Bottom entrance of shaft

VisiMix Off Center Impellers

- The first release of the program allows for entering of mixing devices with :
 - one or two impellers (identical or different)
 - vertical and inclined head-entering shafts
 - bottom-entering mixing devices with single impeller.
- The program outputs include
 - main parameters of hydrodynamics (power, flow velocities, etc.)
 - turbulence (maximum and other local values, etc.)
 - heat transfer corresponding

2020 - VisiMix Bubble Columns



Visimix.Ltd

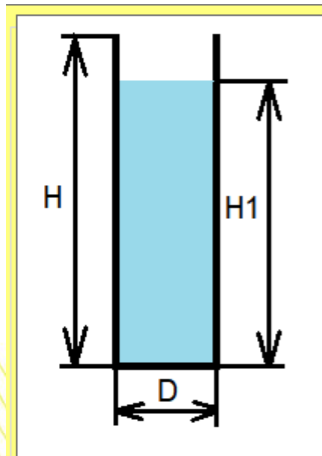
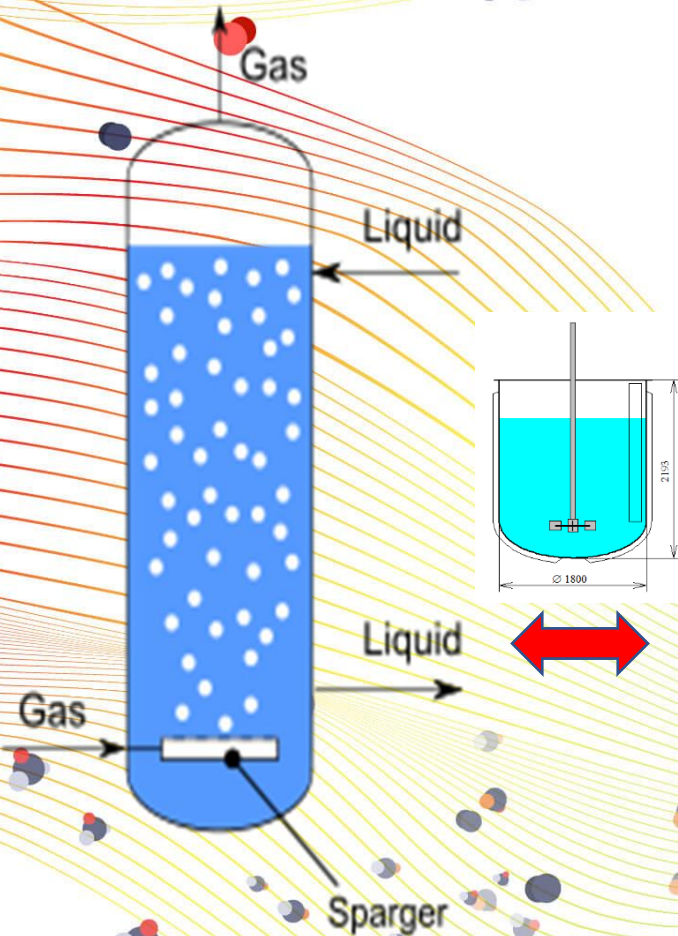
A schematic diagram of a bubble column cross-section. It shows a vertical rectangle representing the column. The total height is labeled 'H' and the liquid depth is labeled 'H1'. The diameter is labeled 'D'. The liquid is represented by a blue shaded area within the column.

Column Diameter (D) , m	1300
Total Column Hight (H) , m	3200
Liquid Depth (H1) , m	2800
Gas Flow Rate , qub.m/s	5
Calculate	
Print	Exit

88

2020 - VisiMix Bubble Columns

Prepare Visimix Input Data for Heat Transfer Calculations in Bubble Columns



Column Diameter (D) , m

1300

Total Column Hight (H) , m

3200

Liquid Depth (H1) , m

2800

Gas Flow Rate , qub.m/s

5

Calculate

Print

Exit

Jacketed Tank with Flat Bottom

Inside diameter, m

1300

Total tank hight, m

3200

Level of media, m

2800

Impeller PITCH PADDLE. MULTISTAGE

Tip diameter(D), m

650

Impellers number

3

Dist. between stages, m

560

Number of blades

3

Pitch angle, deg

30

Width of blade, m

65

Dist. from bottom, m

560

Rotation speed, rpm

0.06284

Motor power, kw

3.998E+05

FLAT BAFFLE-1

Number

4

Width, m

130

Length, m

2800

Dist. from bottom

0

Angle to radius (fi)

0

Circulation Flow, qub.m/s

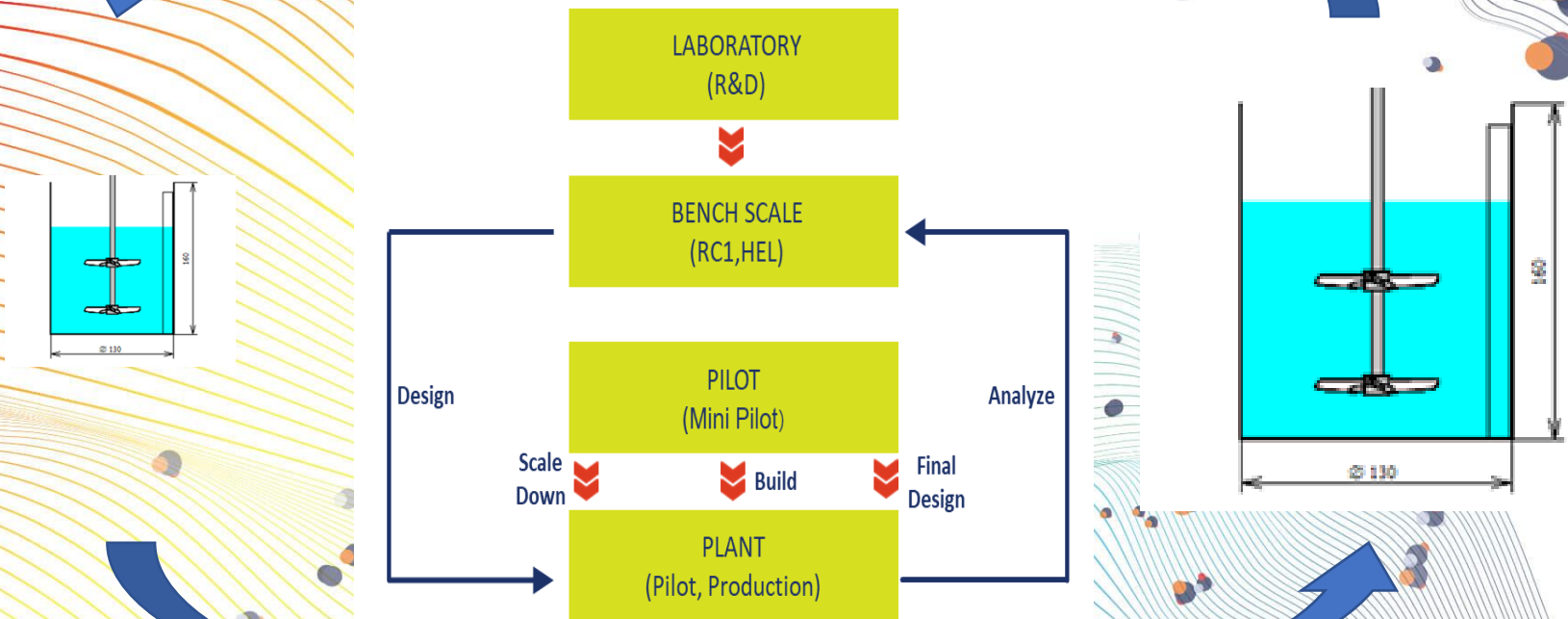
2.652E+05

Near Wall Velocity, m/s

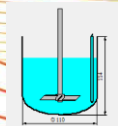
0.3996

VisiMix Scale Up/Down

New Process with Mixing



Process Evaluation Functions



Unit operation:
Suspension of Solid Particles

Open Save As Export to Excel Close Exit

1 C:\Users\Moshe Bentolila\Desktop\lab VSM
2 C:\Users\Moshe Bentolila\Desktop\Production 1.vsm
3 C:\Users\Moshe Bentolila\Desktop\Production 2.vsm
4 C:\Users\Moshe Bentolila\Desktop\Production 3 VSM

Target parameters

Parameter	1	2	3	4	5	6
Project Name	lab	Production 1	Production 2	Productio...		
=== TARGET PARAMETERS						
Complete/incomplete suspension	complete	incomplete	complete	incomplete		
Maximum degree of non-uniformity, axial, %	24.1	24.2	23.4	21.9		
Maximum degree of non-uniformity, radial, %	42.5	13.3	12.7	0.34		
Maximum local concentration of solid phase, kg/cub.m	138	130	129	124		
Minimum local concentration of solid phase, kg/cub.m	44.7	67.3	68.4	79.2		
Average concentration of solid phase in continuous flow, ...	138	130	129	124		
Frequency of collisions of maximum energy, 1/s	0.0698	0.0272	0.0271	0.00233		
=== BASIC DEVICE CHARACTERISTICS						
Tank diameter, mm	110	1800	2000	1800		
Type of impeller	pitched paddle	pitched paddle	pitched paddle	Lightnin A310		
Impeller tip diameter, mm	60	982	1090	900		
Impellers number	1	1	1	1		
Maximum energy of collisions, J	2.89e-12	4.38e-13	4.36e-13	1.37e-12		
Presence of baffles	YES	YES	YES	YES		

Brief description of the application

1. General

This application presents results of VisiMix simulations of selected unit operation for a number of VisiMix projects that differ from each other by equipment design, scale or process regime.

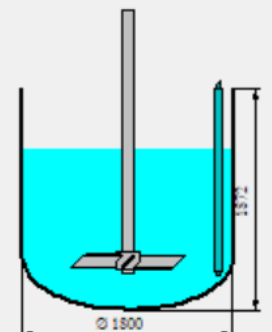
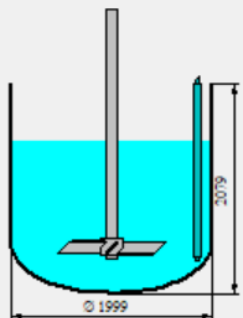
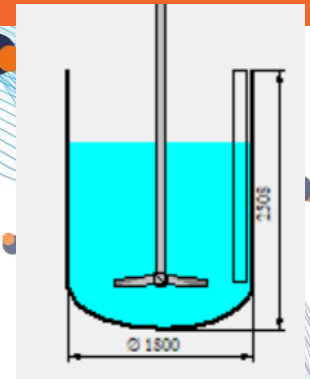
This comparison is performed with respect to unit operation (technical target of the mixing operation defined by user).

Results of different VisiMix projects comparison organized in form of set of tables and graphs containing values of

User Notes:

Target parameters >> Mixing tank data >> Background parameters >>

Basic Mixing Characteristics >> Radial Distribution of solids >> Axial Distribution of solids >> All in One >>





Thank You

For your attention

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PO Box 45170, Jerusalem, 91450, Israel
Tel: 972 - 2 - 5870123 | Fax: 972 - 2 - 5870206
E-mail: info@visimix.com

