

Improving an Ink Resin-Oil Blending Process using VISIMIX™ Software

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Renewable resources. Endless possibilities.

Introduction

- 🌿 Business Need: Sell Ink Resin in Solution.
- 🌿 Seems simple. Mix resin with oil, filter and load a rail car.
- 🌿 But....
- 🌿 Mixing times exceed 4 hours!
- 🌿 Filtration takes 7 hours and 20 bag changes.
- 🌿 Solution: Use VISIMIX™ Software to understand the problem and point toward an effective solution.

Agenda



-  Offset Lithography & Litho Ink
-  Ink Solution Process Objective and Design
-  Performance Problems
-  Using VISIMIX™ Software to understand the situation
-  Improved Process

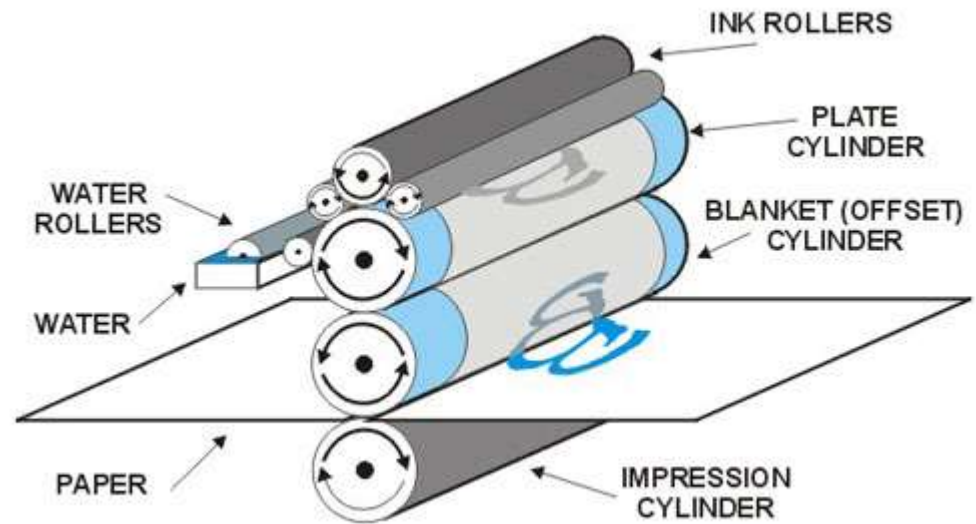
Offset Lithography

Most common printing method for brochures, magazine, catalogs, etc.

Ink consists of pigment, vehicle, and modifiers.

The vehicle is the liquid portion of the ink.

In this example, the vehicle is a solution of a pseudoplastic resin in mineral oil.



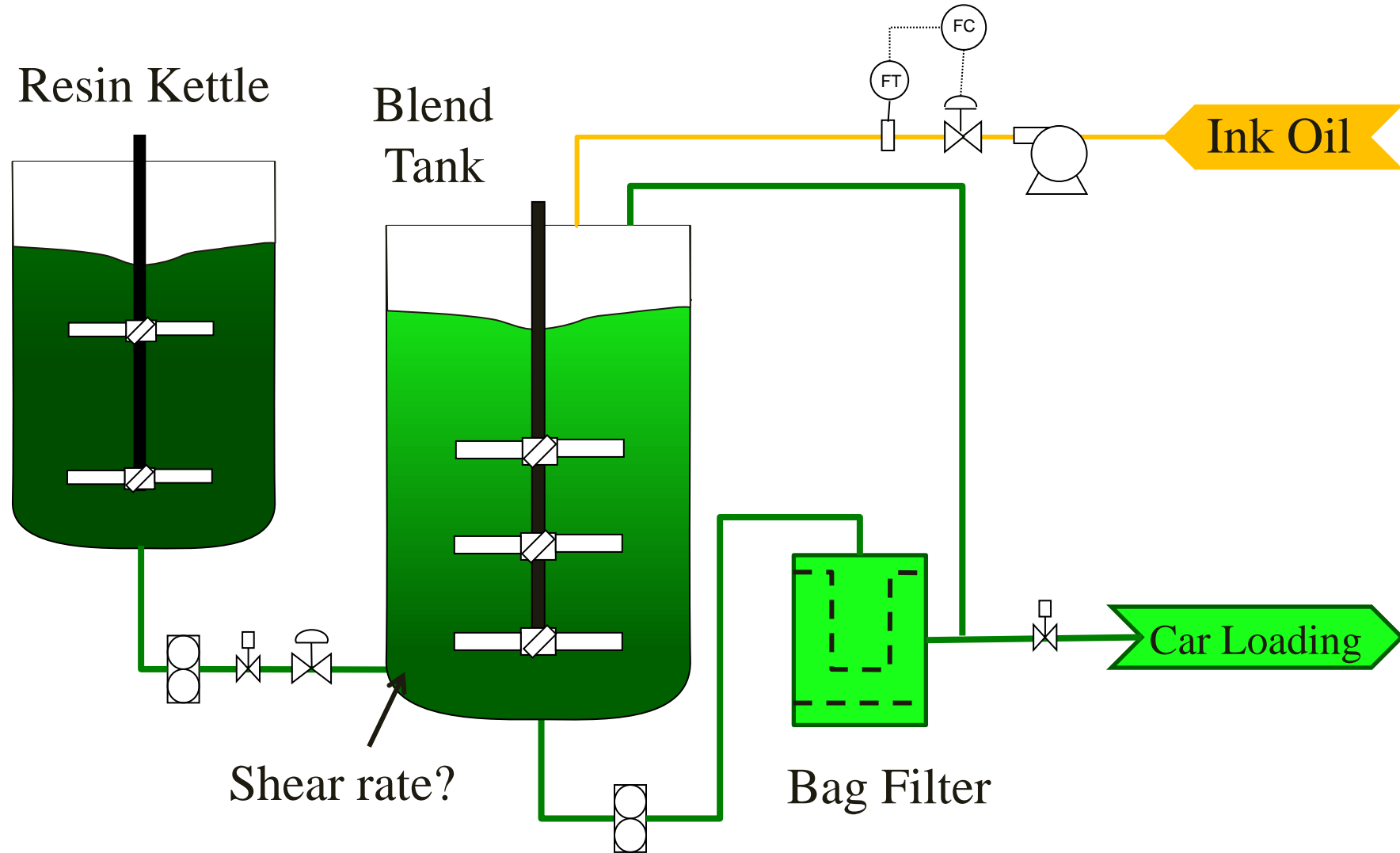
Source: www.offsetprintingtechnology.com

Ink Resin Solution




Cut a Phenolic Resin into Ink Oil

- 🌿 60% Solids
- 🌿 Pump Resin (250 °C) into Ink Oil (150 °C)
- 🌿 The Oil has an Auto Ignition Temperature of 230 °C
- 🌿 Introduce Resin to Oil subsurface
- 🌿 Blend tank has two coil sets (both cooling)

Original Process



Ink Solution: Problems

-  Resin properties not stable in molten state.
-  Batch needs to be circulated for 3 hours to obtain uniform properties.
-  Batch Filtration requires 7 hours and 20 or more filter changes to discharge a batch.

Tank Geometry

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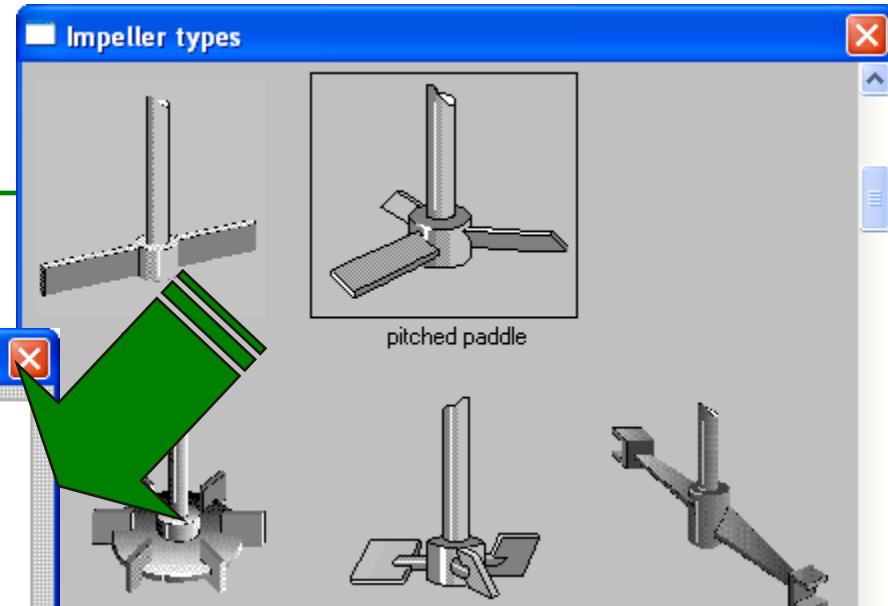
TANK WITH ELLIPTICAL BOTTOM

Inside diameter	11	ft
Total tank height	22	ft
Total volume	1.499e+04	gal
Level of media	18	ft
Volume of media	1.215e+04	gal

Diagram showing a tank with an elliptical bottom. The tank is filled with cyan liquid. The total height is 6706, and the diameter is Ø 3353.

OK Cancel Choose new tank Print Help

Impeller Definition



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PITCHED PADDLE. MULTISTAGE

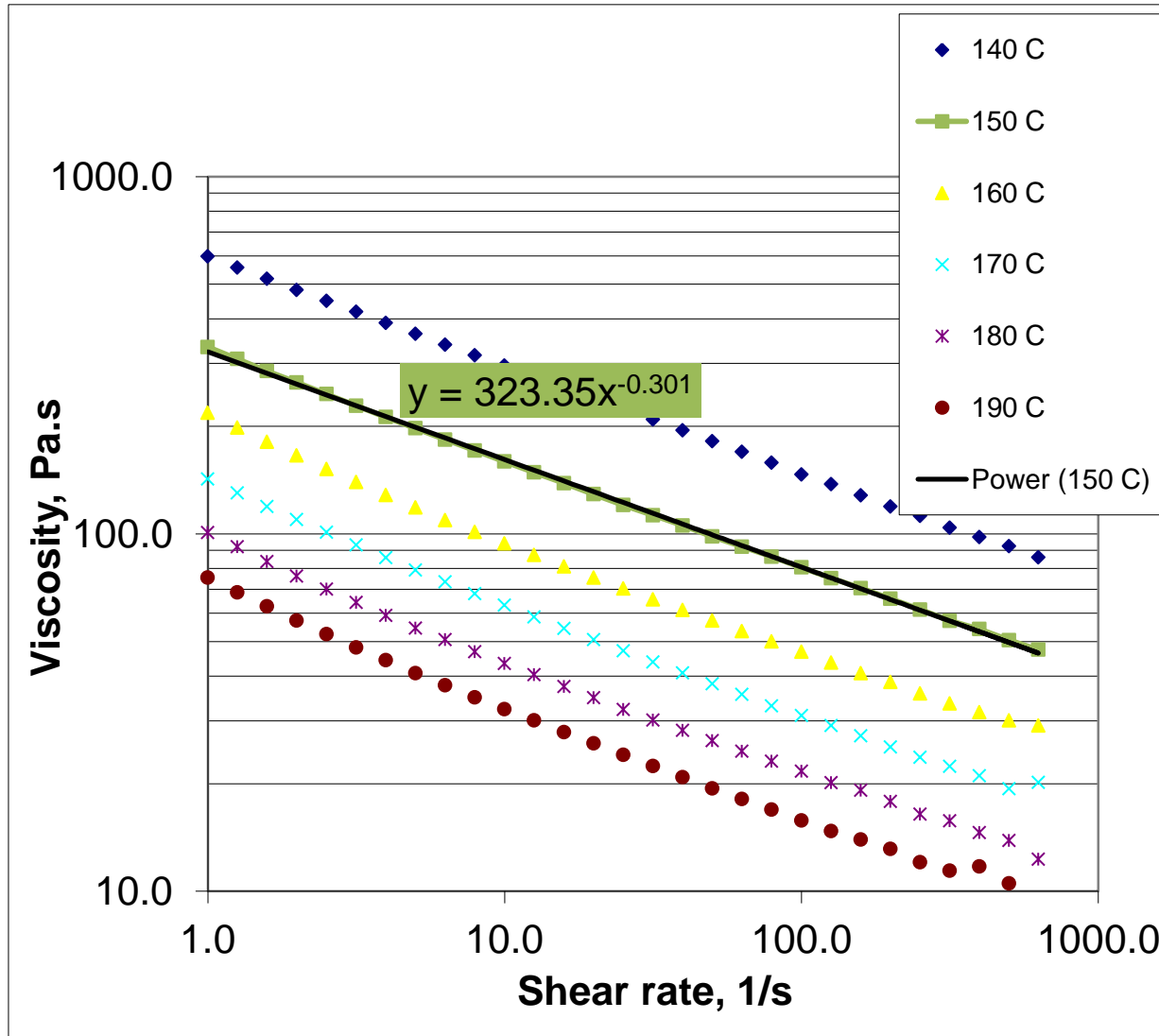
Tip diameter	57.96	in
Impellers number	3	
Dist. between stages	60	in
Number of blades	4	
Pitch angle	45	deg
Width of blade	5.604	in
Dist. from bottom	33	in
Rotational speed	56	Rpm
Motor power	50	hp

Diagram of a stirred tank reactor showing a pitched paddle impeller. The tank diameter is labeled as $\text{Ø } 3353$ and the height of the liquid is labeled as 6706.

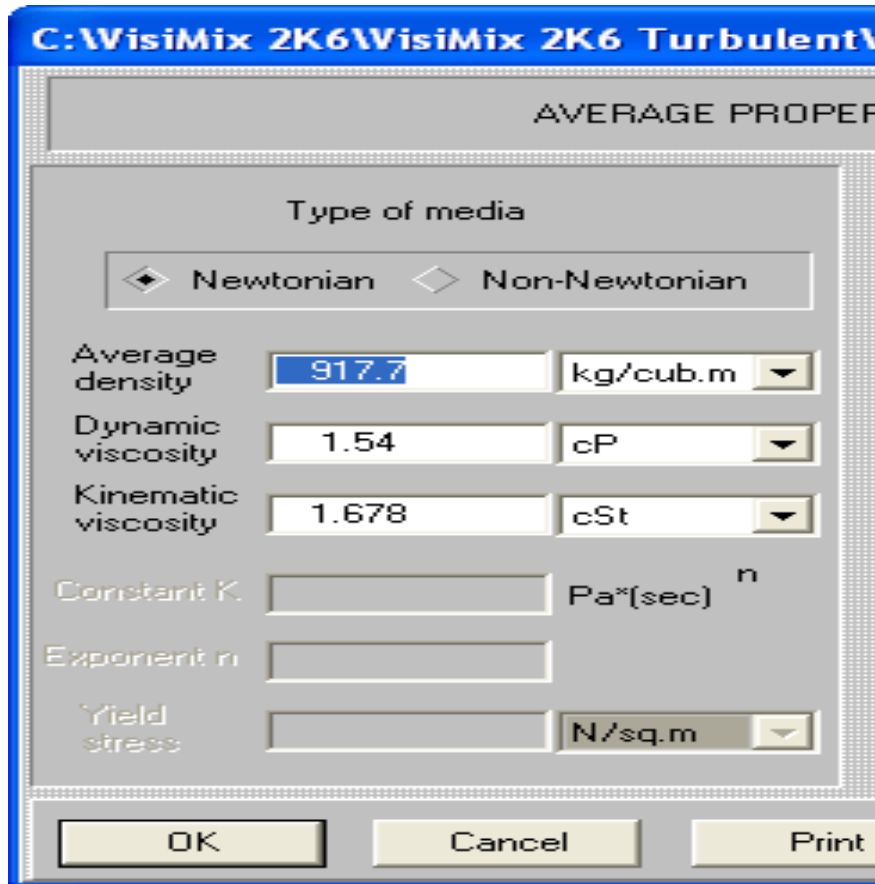
Buttons: OK, Cancel, Choose new impeller, Print, Help

Similar screens for
Baffles and Jacket
definition

Ink Resin Melt Rheology



Material Properties: Ink Oil @150C



C:\VisiMix 2K6\VisiMix 2K6 TurbulentV

AVERAGE PROPER

Type of media

Newtonian Non-Newtonian

Average density: 917.7 kg/cub.m

Dynamic viscosity: 1.54 cP

Kinematic viscosity: 1.678 cSt

Constant K: Pa*(sec)ⁿ

Exponent n:

Yield stress: N/sq.m

OK Cancel Print

 For Non-Newtonian Fluids use a power-law equation:

$$\mu = \tau_0 * \gamma^{-1} + K * \gamma^{n-1}$$

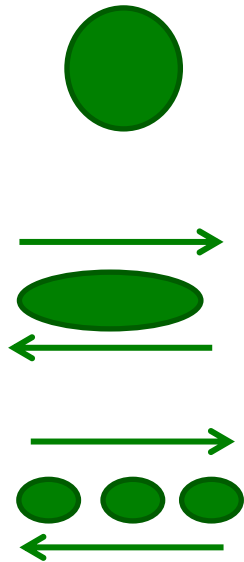
$$[\mu] = \text{Pa S} \quad [\gamma] = \text{s}^{-1}$$

Resin (150C):

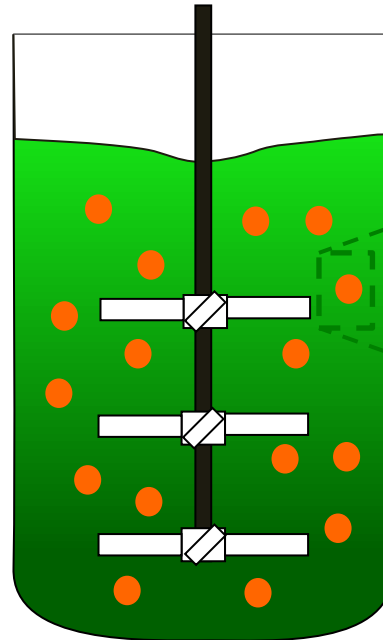
$$K = 323.35$$

$$n-1 = -0.3013$$

The Physical Picture

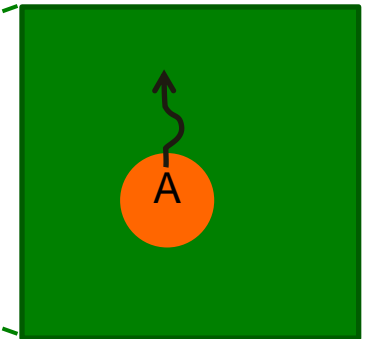


Droplet Formation



Droplet Dispersion

$$N_{A0} = k_c(C_{A0} - C_{Af})$$



Dissolution

Analysis Approach*

- Determine the max. local shear rate
- Calculate the effective viscosity at the given shear rate
- Evaluate the average drop size
- Evaluate radial distribution using the Liquid-Solid mixing option (use drop size for particle size)
- Explore parameters to maximize radial uniformity.

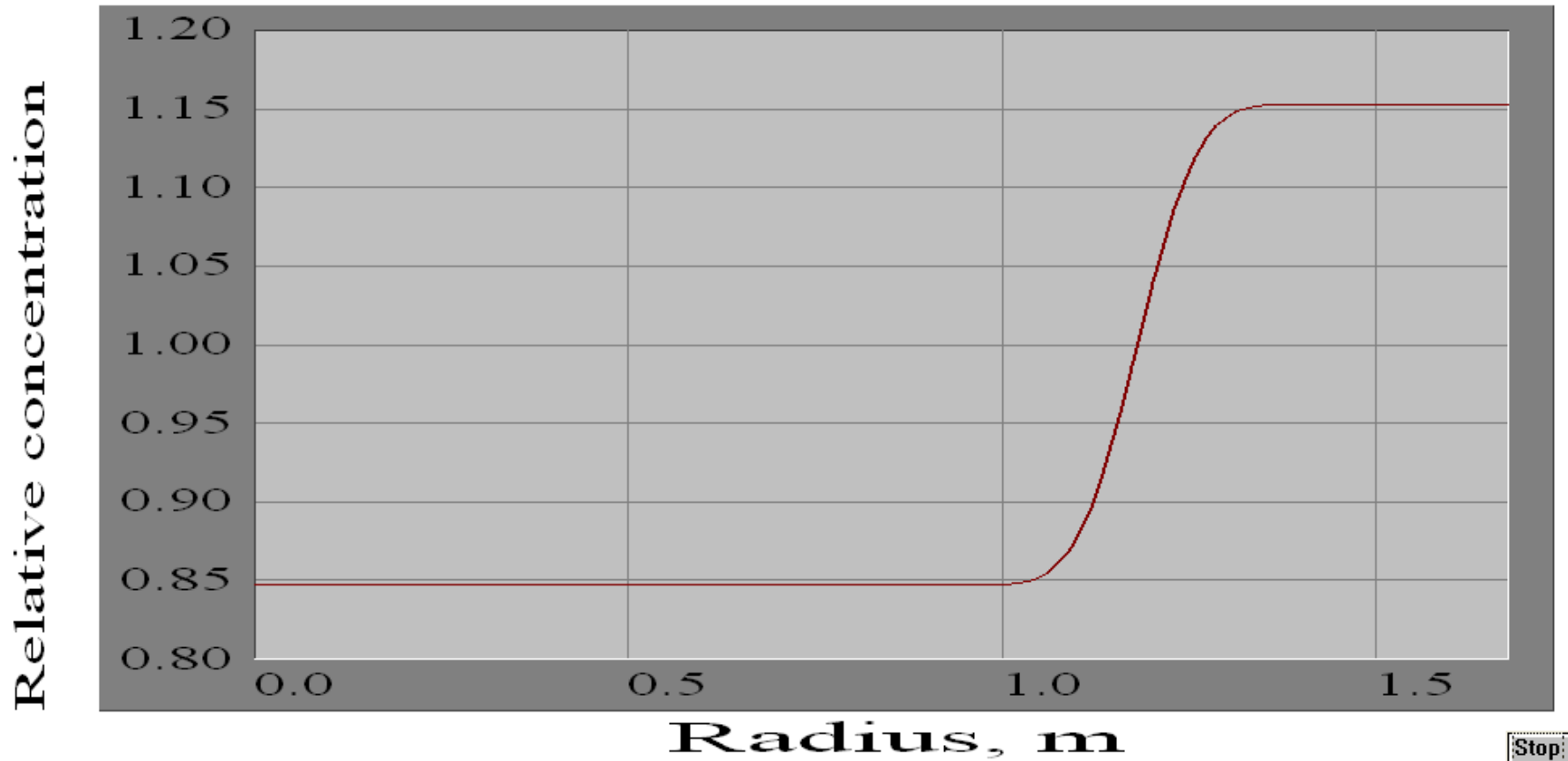
*Leonid Braginsky personal communication May 9, 2007

Results

		Resin Viscosity, [Pa s]		Drop Size, [mm]		Radial Distribution	
Location	shear rate. [s-1]						
150 C							
Baffle	504	49.6		No Data			
Bulk	269	59.9		No Data			
Blade	3950	26.7		No Data			
180C							
Baffle	596	12.4	70.6 (*)				
Bulk	319	15.1	84.2 (*)	+/-15%			
Blade	4670	6.5	39.4 (*)	+/-12%			

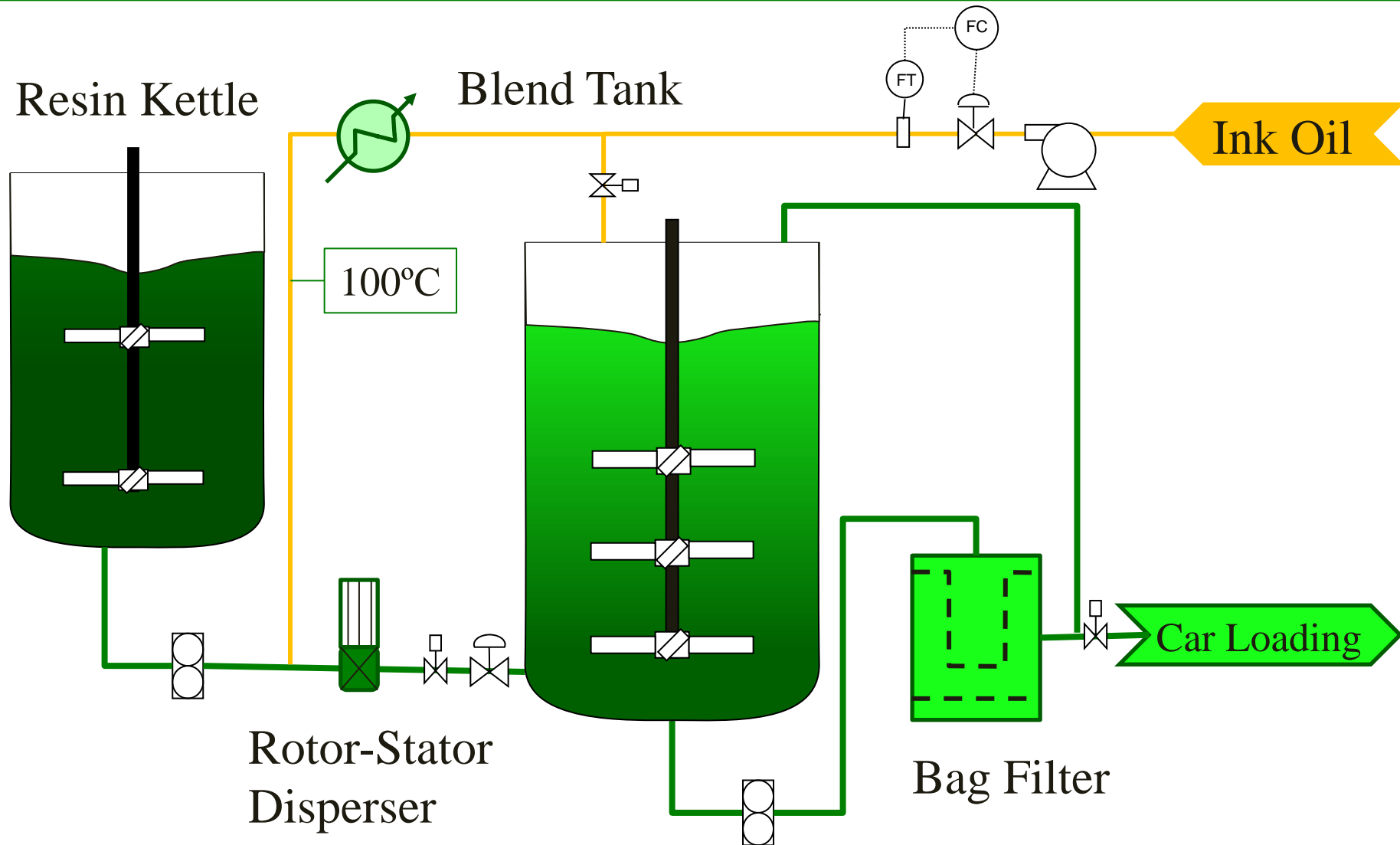
Radial Distribution

RADIAL DISTRIBUTION OF SOLID PHASE



Stop

Improved Process

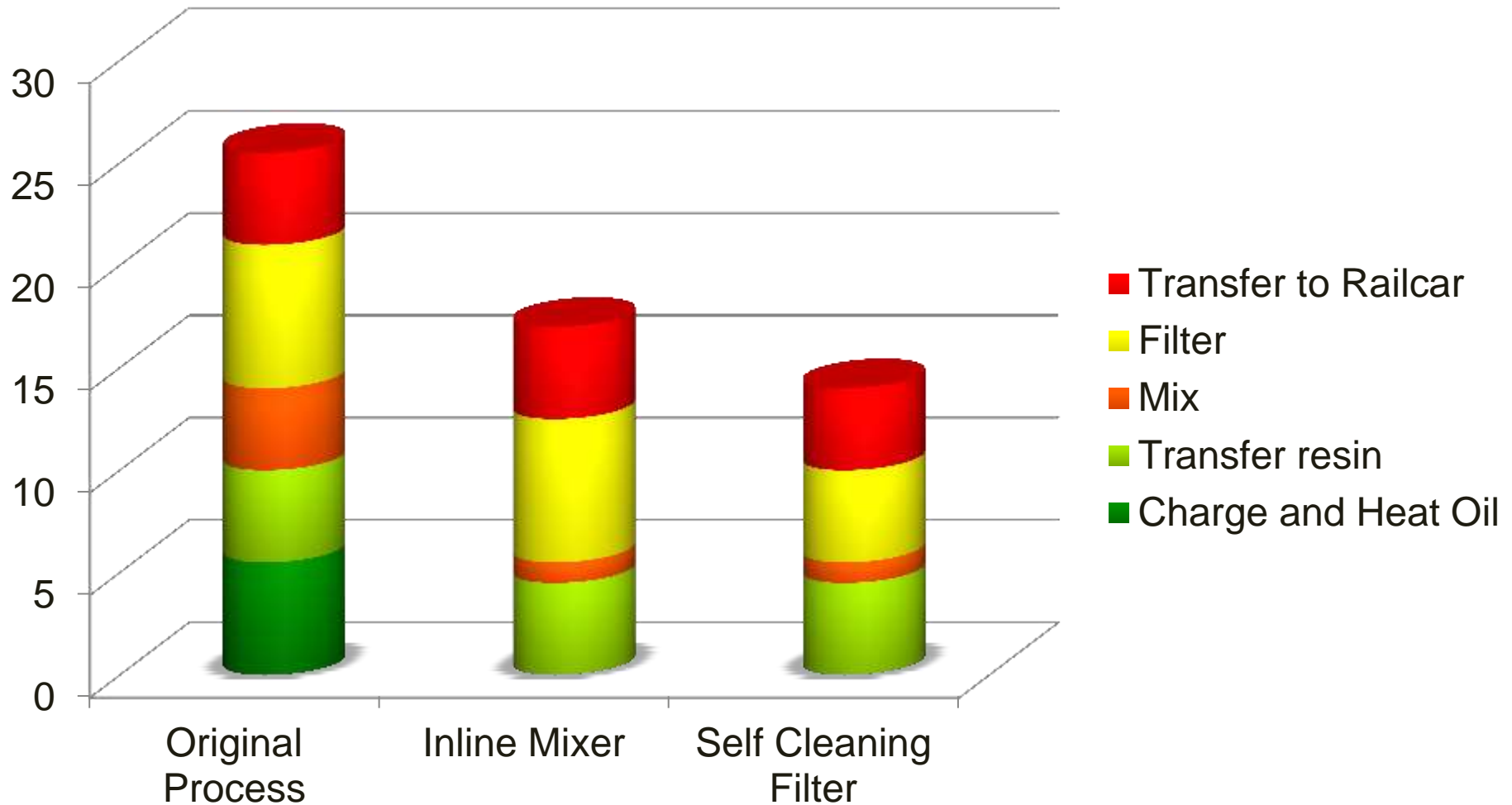


Improved Results







	Old Process	New Process
Cycle Time, Hrs	26	17.5
Filtration Time, Hrs (2 turnovers)	7	7
Filter Changes	20	6

Cycle Time Improvements





Summary

-  An Ink Resin Solution Blending process was exhibiting long cycle times and excessive exposure risk to personnel.
-  Analysis with VISIMIX™ Software elucidated the underlying causes, pointing the way to an improved process.
-  A low capital cost solution was implemented, which reduced cycle time by 33% and filter bag changes by 70%.
-  The blend tank mixer is over designed for the modified process.

Acknowledgements



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