



Deposited via The University of Leeds.

White Rose Research Online URL for this paper:

<https://eprints.whiterose.ac.uk/id/eprint/141266/>

Version: Supplemental Material

Article:

Manga, MS, Willis, D, Nurafiqah, MA et al. (2019) The impact of raw material properties and process conditions on the color of a powdered formulated detergent product.

Particuology, 45. pp. 35-41. ISSN: 1674-2001

<https://doi.org/10.1016/j.partic.2019.01.002>

© 2019 Chinese Society of Particuology and Institute of Process Engineering, Chinese Academy of Sciences. Published by Elsevier B.V. Licensed under the Creative Commons Attribution-Non Commercial No Derivatives 4.0 International License (<https://creativecommons.org/licenses/by-nc-nd/4.0/>).

Reuse

This article is distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND) licence. This licence only allows you to download this work and share it with others as long as you credit the authors, but you can't change the article in any way or use it commercially. More information and the full terms of the licence here: <https://creativecommons.org/licenses/>

Takedown

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

Supplementary information

The impact of raw material properties and process
conditions on the color of a powdered formulated
detergent product

Mohamed. S. Manga*, David. Willis, Nurafiqah. M. Ali and David. W. York

*School of Chemical and Process Engineering, Faculty of Engineering, University of Leeds,
Woodhouse Lane, Leeds, LS2 9JT, United Kingdom.*

Corresponding Author

* Email: M.S.Manga@leeds.ac.uk

S1. Materials and associated properties

Table S1. Liquid and powder components used in this study to produce granular detergent powder.

Raw materials: Liquid components				
Chemical	Functionality	Appearance	Grade	Size
Linear Alkylbenzene Sulfonic Acid (HLAS)	Synthetic anionic surfactant	Brown viscous liquid with shade of color dependent on purity	Commercial, Research, (purity >96%)	-
Oxyethylated isononylphenol (Neonol AF 9-12)	Non-ionic surfactant	Colorless Oily liquid	Commercial	-
Sodium silicate	Builder	White translucent viscous liquid (translucency dependent on purity)	Commercial, Research, (purity >98%)	-
Sokolan	Auxiliary additive (Non-ionic copolymer used as	Yellowish viscous liquid	Commercial	-

antiredosition

agent)

Raw materials: Solid components

Auxiliary

**Carboxy methyl
cellulose (CMC)**

additive
(antiredosition
agent)

White granular
powder

Commercial

Median
particle size
= 70 μm

**Sodium
carbonate**

Builder

White granular
powder

Commercial,

Research,
(purity >99%)

Median
particle size
= 300 μm

Sodium sulfate

Builder

White granular
powder

Commercial,
Research (purity
>99%)

Particle size
250-2000
 $\mu\text{m} \geq 85 \%$

Sodium

**tripolyphosphate
(STPP)**

Builder

White powder

Commercial

Mean
particle size
= 5 μm

**Tinopal® CBS-X
(optical
brightener)**

Auxiliary
additive

Yellow-green
powder

Commercial

Median
particle size

Typical recipe for formulation is;

Ratio of Powder to Liquid	1.94 : 1
Raw Material	Mass of component (g)
Solid Portion	
STPP	11.91
CMC	0.97
Tinopal	0.13
Na ₂ CO ₃	27.09
Na ₂ SO ₄	34.98
Liquid Portion	
HLAS	11.14
Sodium Silicate	21.14
Sokalan	4.95
Neonol AF 9-12	1.40

S2. Breakdown of the samples used for color analysis

Table S2. Breakdown of the different samples that are used for color analysis

	Ingredients		Agglomerator	Drying temperature	Comments
	Dry	Wet			
<i>Sample 1</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven	
<i>Sample 2</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 120°C using convection oven	
<i>Sample 3</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 150°C using convection oven	
<i>Sample 4</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 170°C using convection oven	
<i>Sample 5</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 60° using fluidised bed	
<i>Sample 6</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70° using fluidised bed	
<i>Sample 7</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 80° using fluidised bed	
<i>Sample 8</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 100° using fluidised bed	
<i>Sample 9</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 120° using fluidised bed	
<i>Sample 10</i>	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	unsieved sample

<i>Sample</i> 11	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	sieved with 841µm sieve for analysis of overs
<i>Sample</i> 12	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	sieved with a 841 and a 500µm sieve
<i>Sample</i> 13	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	sieved with a 500 and a 250µm sieve
<i>Sample</i> 14	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	sieved with a 250µm sieve for analysis of fines
<i>Sample</i> 15	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	This sample had less amount of tinopal added (0.09g) which results in a decrease in the L observed compared to above samples
<i>Sample</i> 16	All Commercial grade and all added	All commercial grade and all added	Blender	Drying at 70°C using convection oven,	Recipe kept as the same as sample 15
<i>Sample</i> 17	All Commercial grade and all added	All commercial grade and all added	Coffee grinder	Drying at 70°C using convection oven,	Recipe kept as the same as sample 15
<i>Sample</i> 18	All Commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	Tinopal was added as a powder. Also quantity of HLAS added was lower (8g).
<i>Sample</i> 19	All Commercial grade and all added with exception of Tinopal	All commercial grade; All added with Tinopal added in water	Food processor	Drying at 70°C using convection oven,	Tinopal was dispersed in water recipe same as sample 18
<i>Sample</i> 20	All Commercial grade and all added with exception of Tinopal	All commercial grade; All added with Tinopal added in Neonol	Food processor	Drying at 70°C using convection oven,	Tinopal in neonol (same as sample 18)

<i>Sample</i> 21	All Commercial grade and all added with exception of Tinopal	All commercial grade; All added with Tinopal added in Sokolan	Food processor	Drying at 70°C using convection oven,	Tinopal in Sokolan polymer (same as sample 18)
<i>Sample</i> 22	All Commercial grade and all added with exception of Tinopal	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	No Tinopal added (same as sample 18)
<i>Sample</i> 23	All Commercial grade and all added with exception of Tinopal	All commercial grade; All added with Tinopal added in Neonol	Food processor	Drying at 70°C using convection oven,	Same as sample 20
<i>Sample</i> 24	All Commercial grade and all added with exception of Tinopal	All commercial grade; All added with Tinopal added in Neonol	Food processor	Drying at 70°C using convection oven,	Same as sample 23 but sprayed on rather than poured in
<i>Sample</i> 25	All Commercial grade and all added with exception of Tinopal	All commercial grade; All added with Tinopal added in Neonol	Food processor	Drying at 70°C using convection oven,	Same as sample 24 but addinal spray on of Tinopal in Neonol
<i>Sample</i> 26	All Commercial grade and all added with exception of Tinopal	All commercial grade; All added with Tinopal added in Neonol	Food processor	Drying at 70°C using convection oven,	Same as sample 25 but addinal spray on of Tinopal in Neonol
<i>Sample</i> 27	All commercial grade and all added	HLAS research grade rest is commercial grade and all added	Food processor	Drying at 70°C using convection oven,	HLAS research grade

<i>Sample</i> 28	Sodium carbonate research grade rest are all commercial grade and all added	All commercial grade and all added	Food processor	Drying at 70°C using convection oven,	Sodium carbonate research grade
<i>Sample</i> 29	Sodium sulphate research grade rest are all commercial grade and all added	All commercial grade; All added with Tinopal added in Neonol	Food processor	Drying at 70°C using convection oven,	Sodium sulphate research grade
<i>Sample</i> 30	All Commercial grade and all added	Sodium silicate research grade rest is commercial grade and all added	Food processor	Drying at 70°C using convection oven,	Sodium silicate research grade
<i>Sample</i> 31	Sodium carbonate and sodium sulphate research grade rest are all commercial grade and all added	HLAS and Sodium silicate research grade, rest is commercial grade and all added	Food processor	Drying at 70°C using convection oven,	Sodium carbonate, sodium sulphate, HLAS and Sodium silicate of research grade

S3. Dispersion of Tinopal study

Preliminary experiment was conducted to determine which of the liquids would produce a stable dispersion of Tinopal optical brightener. The stability of the dispersions were compared at before and after heating the liquids to 50°C. Based on this, it was found that water (dissolution), Neonol and Sokolan (uniform dispersions) could be used as a delivery vehicle to incorporate Tinopal within the powdered detergent formulation. Although sodium silicate and HLAS could be used to disperse the Tinopal, the dispersion was not uniform throughout the liquid and it was perceived that this could exaggerate any powder discoloration during the manufacturing process.


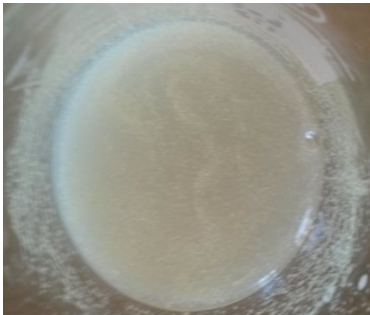
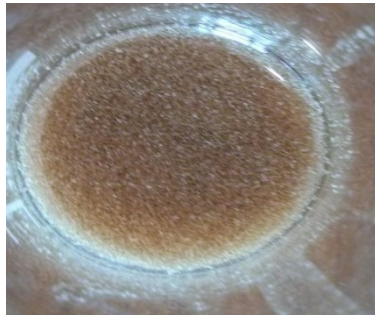


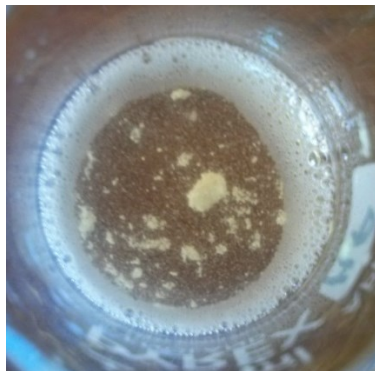




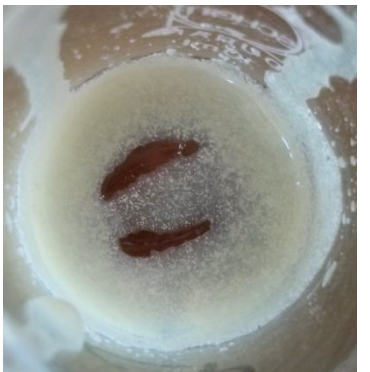

Before Heating		
Tinopal in water	Tinopal in sodium silicate	Tinopal in HLAS
		
Tinopal in Neonol	Tinopal in Sokalan CP5	Tinopal in Sokalan HP 22
		
After Heating		
Tinopal in water	Tinopal in sodium silicate	Tinopal in HLAS
		
Tinopal in Neonol	Tinopal in Sokalan CP5	Tinopal in Sokalan HP 22
		

Figure S3. Assessing the ability of Tinopal to disperse in a range of liquid materials at low and elevated temperatures [Publish in color]

S4. Impact of Tinopal dispersed in water on powder color

Tinopal is soluble in water and this yellow-green color is imparted on the resulting powder.



Figure S4. Digital photographs of powder samples when Tinopal is a) not dispersed in water (sample 18) and, b) dispersed in water (sample 19). [Publish in color]