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PRODUCTION OF POWDER DETERGENT BY SPRAY-MIXING TECHNIQUE SUITABLE FOR SMALL-SCALE INDUSTRIES

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RINGKASAN: *Produk serbuk pencuci pakaian berketumpatan tinggi dihasilkan secara proses pencampuran sembur. Proses ini memerlukan peralatan yang ringkas dan penggunaan tenaga yang rendah, dan proses ini sesuai untuk digunakan oleh industri kecil. Beberapa formulasi telah dibangunkan di peringkat makmal dengan kerjasama sebuah syarikat industri kecil. Ujian keberkesanan produk dijalankan bagi memilih formulasi yang terbaik dari segi prestasi dan kos pembuatannya. Hasil daripada pembangunan produk ini telahpun dipindahkan ke peringkat kilang dan pengeluarannya dimulakan pada bulan Mei 1990.*

ABSTRACT: A high density laundry detergent powder was produced by the spray-mixing process. This process requires low-cost equipment and minimal energy, and is suitable for small-scale industries. Several formulations were developed in the laboratory in collaboration with one small-scale industry. A performance test was carried out to select the best formulation. The commercialization of this formulation was initiated in May 1990.

KEYWORDS: High density laundry detergent powder, spray-mixing process, small-scale industries, performance test.

INTRODUCTION

One of SIRIM's function is to assist small-scale industries upgrade their production technology, quality of products and their overall management system. The project detailed in this paper is one such example which has been carried out by SIRIM to assist a small-scale industry. The numerous enquiries from manufacturers regarding the production of detergent powder initiated this project. Therefore, its aim was to develop a suitable detergent powder, with respect to raw materials and processes, for small-scale industries.

Generally, detergent powder can be produced either by the spray-drying or spray-mixing process. In the former, raw materials are mixed together to form a slurry which is then sprayed onto a spray-drying tower to produce low density-type detergent powder. This process not only requires expensive equipment but is also energy intensive. In the later process, raw materials in the powder form are put into a rotary mixer and a liquid surface active agent is sprayed onto the mixture to produce a high density-type detergent. This process requires low cost equipment and minimal energy. It is therefore a preferred process than the spray-drying one, to small-scale industries.

In this study an effective detergent powder in cleaning various types of soils as compared to another commercial product was looked into.

MATERIALS AND METHODS

Equipment

The equipment used to develop the detergent powder was the Rotary Mixer, type of V-Blender, which has an internal agitator for breaking up lumps and a liquid-spraying system.

Raw Materials

The materials used and their functions are as shown in Table 1.

Formulation

A total of 10 formulations listed in Table 2 were developed. These formulations were selected based on their effectiveness and competitiveness with other products available in the market. The selection of materials, their percentage and costs were also taken into account to ensure a quality product at a reasonable cost.

Table 1. Raw materials and their functions

Raw Material	Function
Surface active agent - Nonyl phenol ethoxylate, 1OEO	Reducing the adhesion between dirt and the fabric surface to be cleaned, thus increasing the ease with which the dirt can be removed.
Sodium tripolyphosphate	Forms soluble complexes of calcium and magnesium ions which cause hardness, such condition prevents re-deposition of soil on laundered fabrics.
Sodium metasilicate	Improve the efficiency of the detergents and prevent re-deposition of soil on laundered fabrics.
Sodium carbonate	Improve the alkalinity and softens hardwater
Sodium perborate	Bleach the organic colour soil from the fabric.
Carboxyl methyl cellulose (CMC)	As a soil suspending agent, prevents re-deposition on the fabric surface.
Optical whitening agent	Makes the fabric brighter and whiter.
Protease	Assist in the removal of proteinaceous stains such as blood, body secretions and food.
Perfumes	Masking undesirable and offensive odours and for imparting a pleasant aroma.
Sodium sulphate	As a filler and to improve the physical properties such as good flow ability, no caking of the powder and good solubility.

The materials in powder form were measured according to specified ratios in the formulations given (Table 2), were mixed in the Rotary Mixer a type of V-Blender. The liquid surface active agent was then sprayed onto the mixture until a homogenous compound was obtained.

Cleaning Performance Test

The effectiveness of the product in cleaning various types of soils were evaluated, using the method described below.

Artificially soiled test fabrics

Pieces of cotton cloth measuring 5 x 5 cm were evenly stained with one of the seven stains. The stains used were coffee, tea, curry, egg, soya sauce, chocolate and chilly sauce.

Table 2. Formulation for detergent powder

Raw Material	Formulation (% of Total)									
	1	2	3	4	5	6	7	8	9	10
Nonyl phenol ethoxylate, 10E0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	10.0	10.0	10.0
Sodium tripolyphosphate	5.0	10.0	15.0	20.0	25.0	30.0	25.0	25.0	30.0	25.0
Sodium metasilicate	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Sodium carbonate	20.0	20.0	20.0	20.0	15.0	10.0	10.0	5.0	0.0	10.0
Sodium perborate	15.0	10.0	5.0	0.0	5.0	5.0	10.0	15.0	15.0	10.0
Carboxyl methyl cellulose (CMC)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Optical whitening agent (Tinopal CB-SX)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Protease	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Perfume	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Sodium sulfate	31.75	31.75	31.75	31.75	26.75	26.75	26.75	31.75	31.75	31.75

Test method

The formulations 1 - 10 were tested for its effectiveness in cleaning the various types of soils. A control was performed using water instead of detergent. For comparison purposes a commercial product available in the market having similar compositions was also tested (Table 3).

Five grams of each formulation was dissolved in conical flasks containing 250 ml water. Each of the seven soiled fabrics were soaked in each of the above dissolved formulations. The washing process was allowed to proceed for 15 mins, 150 rpm at room temperature. After washing the fabrics were rinsed for 1 min with 500 ml of water and was later dried. Once dried the effectiveness of the formulations were determined based on its efficiency in removing the soils.

Table 3. Main components of the commercialized product

Material	% weight/weight
Non-ionic surface active agent	12.80
Sodium tripolyphosphate	26.47
Silicate, as SiO_2	9.68
Protease	Not known
Optical whitening agent	Not known

A scale of 1 - 3 was used to assess the extent of soil removal.

3 – soil fully removed
2 – traces of soil left
1 – soil not removed at all

The above tests were repeated at shaking times of 30 min and 60 min.

RESULTS AND DISCUSSION

The cleaning performance test of the various formulations against the soil types are as shown in Table 4. It is observed that several soils are more difficult to remove than others. The order of difficulty is as follows: curry, soya sauce, egg, tea, chilly sauce, coffee and chocolate. It is believed several factors contribute to this order; the solubility of the stain in the wash medium, the chemical composition and particle size of the stain, the interdependent action between substrate and the stain.

From Table 4, formulations 5, 6 and 7 were observed to be more effective or comparable to the commercial product X as detergents. The formulations which were less comparable to product X were 1, 2 and 3, while formulations 4, 8, 9 and 10 were nearly as comparable to product X. The contents of the surface active agents, nonyl phenol ethoxylate and sodium tripolyphosphate are clearly seen to influence the effectiveness of the product. Although the amount of surface active agent in formulations 1, 2, 3 and 5, 6, 7 are the same, results indicate that the later three formulations serve as better detergents. This can be attributed to the larger amounts of sodium tripolyphosphate in the later three formulations. It is observed that the formulations with 15% surface

Table 4. Cleaning performance test of the various formulations (F) against soil types

Soil types	Coffee			Tea			Curry			Egg			Soya Sauce			Chocolate			Chilly Sauce			Total		
F	15	30	60	15	30	60	15	30	60	15	30	60	15	30	60	15	30	60	15	30	60	15	30	60
A	1	2	2	1	1	1	1	1	1	1	1	2	1	1	1	1	2	2	1	2	2	7	10	11
1	3	3	3	1	2	3	1	1	2	1	2	3	1	2	2	3	3	3	2	2	3	12	15	19
2	3	3	3	1	2	3	1	1	1	1	2	3	1	2	2	3	3	3	2	2	3	12	15	19
3	3	3	3	2	2	3	1	1	1	1	2	3	1	2	2	3	3	3	2	3	3	13	16	18
4	3	3	3	2	2	3	1	1	1	1	2	3	2	2	2	3	3	3	3	3	3	16	16	19
5	3	3	3	2	3	3	1	1	2	2	2	3	2	2	2	3	3	3	3	3	3	16	17	19
6	3	3	3	2	3	3	1	1	2	2	2	3	2	2	2	3	3	3	3	3	3	16	17	19
7	3	3	3	2	3	3	1	1	2	2	2	3	2	2	2	3	3	3	3	3	3	16	17	19
8	3	3	3	2	2	3	1	1	2	1	2	3	1	2	2	3	3	3	3	3	3	14	16	19
9	3	3	3	2	2	3	1	1	2	2	2	3	1	2	2	3	3	3	3	3	3	15	16	19
10	3	3	3	2	2	3	1	1	2	1	2	3	1	2	2	3	3	3	3	3	3	14	16	19
X	3	3	3	2	2	3	1	1	2	2	2	3	2	2	2	3	3	3	3	3	3	16	16	19

Note: A = Without detergent (control)
X = Commercial product

active agent and 25/30% sodium tripolyphosphate were the most effective detergent while formulations with similar amount of sodium tripolyphosphate but 10% surface active agent required longer washing time. Sodium carbonate content on the other hand, does not affect the detergency of the formulations greatly.

This is noted in formulations 1, 2 and 3 where sodium carbonate content was high at 20% and sodium tripolyphosphate content low, these formulations were less effective as detergents. The effect of sodium perborate is observed in formulations 1 and 4. The cleaning performance of formulation 1 with only 5% sodium tripolyphosphate and 15% sodium perborate and formulation 4 with 20% sodium tripolyphosphate and no sodium perborate was much better if washing time was extended.

CONCLUSION

It can be concluded that to produce a quality detergent or one that is comparable to the commercially available detergent, the contents of nonyl phenol ethoxylate and sodium tripolyphosphate be not less than 15% and 25% respectively. From this study, formulations 5, 6 and 7 fall in this category and thus serve as potential detergents. When considering the cost of raw materials formulation 5 seemed to be the lowest and hence was recommended as the most economical and quality detergent to the small-scale industry (Table 5). The company has since (May 1990) started producing the formulation commercially (Figure 1).

Table 5. Cost of raw materials for formulations 5, 6 and 7

Raw Material	Cost of Formulation (F) (RM)		
	F5	F6	F7
Nonyl phenol ethoxylate, 1OEO	0.66	0.66	0.66
Sodium tripolyphosphate	0.60	0.72	0.60
Sodium metasilicate	0.15	0.15	0.15
Sodium carbonate	0.12	0.09	0.08
Sodium perborate	0.15	0.15	0.30
Carboxymethyl cellulose (CMC)	0.11	0.11	0.11
Optical whitening agent (Tinopal CB3-X)	0.23	0.23	0.23
Protease	0.13	0.13	0.13
Perfume	0.24	0.24	0.16
Sodium sulfate	0.16	0.16	0.16
Total	**2.55**	**2.63**	**2.66**

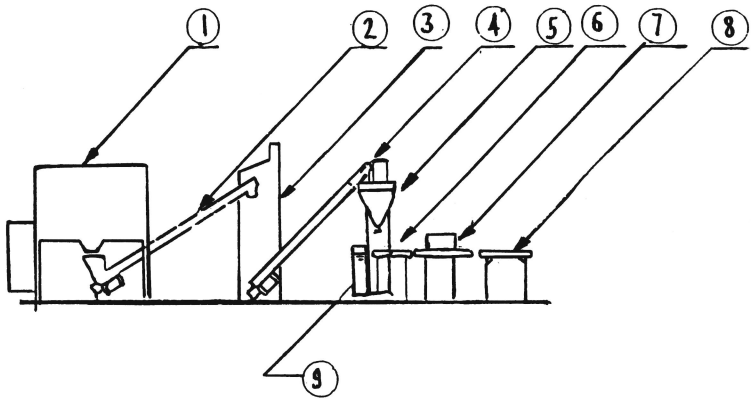

Figure 1. *Engineering set-up to manufacture detergent powder*

1. Powder blender
2. Screw conveyor
3. Dust-proof storage bin
4. Screw conveyor
5. Powder filler
6. Filling bench
7. Bag sealer
8. Packing and cartooning bench
9. Bag opener

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