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Polyethylene wax emulsion production by using the stabilizer substances of ionic surface

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Polyethylene wax (PEW) is a very efficient and valuable product that the production rate of this material is more than 10,000 tons per year in Iran petrochemical complexes, and modification it to oxidized wax for use in various industries such as paint, polymer, coating industry, and also one of the most widely used application of it is in production the emulsion of polyethylene waxes and, etc., which is economically very valuable. The aim of conducting this project is the production of water-based PEW emulsion, which requires the use of oxidized polyethylene wax (o-PEW). Produced polyethylene wax emulsion has wide and various applications in coating the different levels. Anionic, cationic and nonionic surfactants were used to prepare emulsion of polyethylene wax kind. In this project, the various percentages of surfactants and their effect were investigated on the made emulsion that the obtained results reflect this fact that the use of different percentages of surfactants does not cause change in the pH of the made emulsion. Nevertheless, stability, uniformity, and size of particles of obtained emulsion, are sustained non-negligible changes by changing the weight percentage of surfactants. In continue, using the potassium hydroxide (KOH) and its effect on the pH of the obtained emulsion were examined that obtained results showed an increase in the amount of pH of the emulsion with increasing the amount of used potassium hydroxide. In continue the effect of stirring speed and also conducting the tests of obtaining the acid number for synthetic waxes and also conducting the dynamic light scattering test (DLS) on the made emulsion were investigated to measure the size of synthesized particles.

Keywords: oxidized wax, polyolefins, polyethylene, polyethylene wax emulsion

INTRODUCTION

According to global statistic, the family of polyolefins are considered as one of the biggest production and consumption groups of polymer in the worldwide [1,2]. Polyolefins emerged since the early 1950s with the discovery of Ziegler-Natta catalysts accidentally [3,4]

Types of polyethylene (PE) and polypropylene (PP) are the most important polymers of this large family [5]. So far, this class of polymers was synthesized laboratory and industrial with different generations of catalysts such as Ziegler-Natta, metallocene, Philips, etc [6]

Wax is derived of the word of Weax the name that Anglo-Saxon people were put on wax. Today, the word of wax covers great bunch of materials that are obtained from natural and synthetic, oil, plant, animal and mineral sources. Wax usually refers to substances that have low melting point, and are solid at environment temperature and become soft by heating, hard with cold and also create shiny and bright surfaces that, usually are divided into natural and synthetic waxes depending on that obtained of what source [7].

The first polyethylene resin was produced in Great Britain in March 1933 by Eric Faucet [8]. Faucet and his colleagues were studying the reaction of organic compounds in high temperature and pressure between 1000 and 3000 atmosphere. They found that a hard solid of ethylene in the presence of low levels of oxygen is obtained in these circumstances. Before this, British researchers had tried to produce a durable polymer at low pressures but their products were oil with low molecular weight oil or grease. The chemical structure of oxidized polyethylene wax (o-PEW) allows it to form emulsion in water in the presence of surface stabilizers and organic and inorganic bases. More stable emulsions are formed whatever the degree of oxidation the wax is more [9]

These emulsions are used for polishes, a lubricant for natural and synthetic fibers, surface coating of fruits, separating of the template for polyurethane, wetting agent for used fillers and fiber in reinforcing polymers and in the paper industry.

Emulsion is a mixture of two or more immiscible liquids (non-mixing) . It means the integration of the two liquid with liquid is named emulsion if two liquids do not solve in each other and turn in suspended state or in other words, emulsion is used at time that a liquid is as dispersed (minor phase) in

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another phase as the continuous phase (whole or base phase) and the boundary between the two phases is called internal phase. Emulsions are not formed spontaneously and they also tend to be unstable after the formation. Therefore, an emulsifier is required as a surfactant or the same surface active material and also heating and stirring to form a stable emulsion. Of course, used emulsifiers are different depending on the type of use of emulsion,. So the main combinations of an emulsion can be expressed as follows:

A) Internal or discontinuous phase or dispersed (partial part of emulsion that is diffused in whole or base part, such as fine particles of oil-in-water (oil-in-water emulsion O / W)

B) The external or continuous phase (whole or base part of an emulsion that includes partial or diffused part, the water in oil emulsion in water.

C) Emulsifier material (Stabilizing material of the emulsion that prevents electrostatic dispersion and disintegration of emulsion; mechanism of action of emulsifier is based on electrostatic force).

How to form an emulsion base material is so that: a force of surface tension arises at the interface limit of contact between them when two immiscible materials, such as water and oil are put in contact with each other , such force is in a state that two materials tend to separate , and the force required to separate the two phases becomes stronger when this force increases emulsifiers or same surface stabilizers act in a manner that causes to reduce this interfacial surface tension, also causes to change in properties of internal level the surface stabilizers are materials with amphiphillic properties that means include the section of soluble materials in water (hydrophillic) and also the soluble section in oil (lipophillic).

When, emulsifier is added to the oil and water phases, the hydrophillic part of molecule orients to the water and the lipophillic part of molecule orients toward oil phase. The micelle is formed by accumulating the emulsifier molecules at the internal boundary between two phases.

Micelles acts in a way that the hydrophillic head of emulsifier orients towards the water and the lipophil head of it orient towards the oil. Micelles are usually "a spherical shape or forms of Liposome or Bilayers, but most of micelles are spherical.

Emulsifiers are surfactant molecules that are absorbed in surface by droplets formed during homogenization and form a protective layer that prevents that droplets accumulate and get too close to each other.

Emulsifiers must have three properties associated with the increasing in formation and stability of emulsions: they quickly absorbed into the droplets formed during homogenization, reduce internal surface tension and form a protective layer that prevents accumulate of droplets [10].

In addition, stabilizers also are used to increase the viscosity of the continuous phase of emulsifiers. They increase the stability of emulsion by slowing down and postpone the movements of droplets that are suspension in the continuous phase or external phase [11]

Many factors affect the stability of emulsion such as: oil amount, the ratio of volume fraction of oil to water phase, Blending method, water quality, and size of particles, viscosity, surface tension and temperature [8].

Emulsion stability is more whatever the size of particles, surface tension is less and viscosity of emulsions is more. The shelf life of many of food emulsions depends on rheological properties of its phases (becoming creaming the oil droplets depends on the viscosity of the water phase) [9]

With these descriptions, generally three methods used to produce polyethylene wax emulsion (PEW) have been stated that include:

1. The emulsion of water to Wax
2. The emulsion of Wax to Water
3. Pressure emulsification

Emulsions of Waxes have very broad applications in covering various levels. For example, paper boxes that have wax cover are used in the packaging of foodstuffs such as fish and vegetables.

Wax covering has caused to increase the unity and strength of packaging against moisture resulting from the use of ice or refrigerator in storage of these materials. Other properties such as luster and brightness, resistance against slipping, and printing depend on the properties of the wax covering.

Usually these types of packaging are disposable and then are discarded. Another application of waxes, especially polyethylene waxes, is use it to apply the covering on the fruits in order increase their lifetime, doing Lynette the cloth (removing lint and softening the fabric) and so on. Thus, the aim of conducting this project is the use of two oxidized waxes of Imam port and Amir Kabir Petrochemical with three different acid numbers. We plan to investigate the different percentages of nonionic and anionic and alcoholic surfactants of each alone, or by using a mixture of surfactants and also their impact on manufacturing solution and also stirring conditions and calculation and obtaining the acid number and also conducting dynamic light scattering test (DLS) on the made emulsions in this project.

MATERIALS AND METHODS

Chemical substances and equipments

Imam port and Amir Kabir petrochemical waxes were used as polymer wax that chemical characteristics of these waxes have been brought in Table 1.

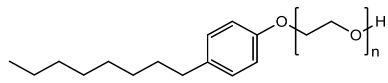
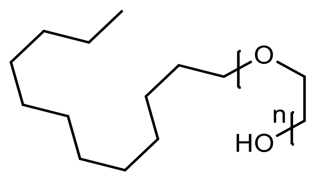
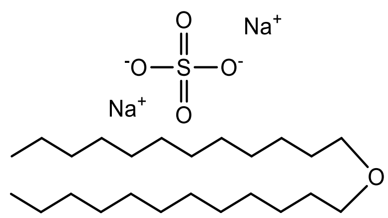
Table 1: Properties of oxidized wax of Imam port and Amir Kabir Petrochemical complex

Row	Type of Oxidized Wax	Acid number (mg KOH)	melting point(°C)	Density(gcm^{-3})	)(ρ)viscosity) (10P)(Pa.s)($kgm^{-1}s^{-1}$)	Ash percentage
1	Imam Port Petrochemical Complex	23	99	0.92	290	0.1
		19	101	0.92	310	0.1
2	Amir Kabir Petrochemical	17	84	0.88	230	1/0<

Toluene, ethanol, phenolphthalein, hydroxide potassium, and xylene, all were used from Merck Company of Germany with high purity percentage and without any initial manipulation

In addition, used surfactants were provided from the Company of Kimiyaran .chemical structure and properties of used surfactant have been brought in Table2.

Table 2: Chemical structure and properties of used surfactant

Row	brand name of surfactant	The name stands for	chemical name	Chemical formula	chemical extensive structure
1	Nonylphenol Ethoxylate	KENON	Nonylphenol polyethylene Glycol Eter	$C_9H_{19}C_6H_4(OCH_2CH_2)_nOH$	
2	Lauryl Alcohol Ethoxlates	KELA	Lauryl – Myristryl alcohol Ethoxylate	$C_{12}H_{25}(O\ CH_2CH_2)_n\ OH$	
3	Soudium Lauryl ether sulfate	TEXAPON	Soudium Lauryl ether sulfate	$CH_3(CH_2)_{10}CH_2(OCH_2CH_2)_2OSO_3Na$	

Also, devices and equipments used in the preparation of emulsion include; heater-styrer magnetite, laboratory glassware dishes, digital scale with an accuracy of four decimal numbers (ten thousandth of a gram), glass reactor 500 or 250 ml of Pyrex, a mechanical twin-engine stirrer of German (Heidolph, RZR 2041, Germany), dynamic light scattering apparatus (DLS), (Malvern, ZEN 3600, Canada) made in Canada are used to determine the average of the size of synthesized particles.

Applicable methods to produce the emulsion

The following tests have been used to detect the Polyethylene wax and Polyethylene wax emulsion

1. Measuring the acid number
2. Investigate the relationship between the amount of potassium hydroxide and pH of made emulsions
3. Investigate the relationship between the concentration of surfactant and emulsion characteristics
4. Dynamic light scattering tests (DLS)

Method of measuring the acid number

98-1386 ASTM standard method that is special for determining the acid number of waxes is used for doing this measuring. By definition, the acid number is KOH mg necessary to neutralize one gram of sample.

For measuring, we spill 1 to 2 grams of oxidized polyethylene wax sample in adish containing 40 ml of xylene and so we heat up the sample to completely dissolve in xylene, then add 3 to 5 drops of phenol phthale that is previously prepared (1 g of phenolphthalein Merck has weighed on balloon of Zhozheh 100 to volume with 95% ethanol) to the solution and then we titer it with a KOH solution in 0.1 N ethanol that it is prepared (we weight 6.6 g of potassium hydroxide and volume it with ethanol in a liter volumetric flask),the amount of consumed potassium hydroxide solution is measured when the pink color remains constant for 10 seconds and we compute the acid number by the following equation.

That here, A; is the consumed amount of potassium hydroxide in milliliters (ml), N; normality of consumed potassium hydroxide solution, and B; weight of sample in grams (g)

Dynamic light scattering test (DLS)

Device of dynamic light scattering (DLS), the ZEN 3600 model from Malvern Company, made in Canada was used to measure the average of size of prepared particles.

All samples were done for performing the test of DLS for 20% of the solids and the maximum the measuring wavelength (λmax) was equal to 633 nm in this system. All tests related to the results of DLS are attached

Overall production process of polyethylene wax emulsion

The first public stage of emulsify process, is dissolving the considered wax (if it is needed to help of heat) . After doing this process completely sufficient amount of alkali (base) is added to it for saponification of an arbitrary number of functional groups within the wax.Then, a sufficient amount of surfactant is added to the reaction mixture and the emulsion is allowed to be formed under suitable stirring. If homogeneous also is used in the manufacturing process of emulsion, shear stress due to it is effective on the size of the particles in the emulsion.In addition, in this case, the role of saponification process of the wax has less importance because the mechanical force exerted by the homogenizer is sufficient. In general, more stable emulsions are created in a state that are created by both the saponification and optimize mixing factors.

It is worth noting that, we used the Water to Wax method in this project in creating the emulsion and the two waxes of Imam Port and Amir Kabir Petrochemical were used with acid number (19, 23, and 17) as noted above. In this way that, on a laboratory scale to 20 or 40 grams - depends on the percentage of solid that we want to provide-, is melted of the wax and then a sufficient amount of surfactant (in accordance with the formula) is added to it. After it the wax mixed with surfactant with little interval (after about 10 minutes) and its color changed and we add the water and potassium hydroxide solution to the mixture surfactant and wax that the mixture of wax in water turns to the absolutely homogeneous solution with white color. Then it is allowed that this solution is well stirred for 30 minutes at a constant temperature (boiling point of water) by using a shaking round of speed round (300 rpm to 800) . While the emulsion is stirred also is allowed that the temperature of it comes down to temperature of environment. Then the considered parameters means pH, stability, color and clarity are investigated.

RESULTS AND DISCUSSION

As it is noted in previous sections, PE wax emulsion commercially was tested and used with non-ionic emulsifiers include phenol ethoxylates Nonyl (KENON),alcohol ethoxylates Lauryl (KELA), and ether sulfate Lauryl sodium (TEXAPON) with certain proportions that have been brought in following.

The produced formulations in this project by using oxidized wax of Imam Port and Amir Kabir

Petrochemical with acid numbers (19, 23, and 17) with different percentages of emulsifiers and different percentages of are as follows:

Emulsions with different percentage of mixtures and their properties

As it can be seen in following tables, various amounts of emulsifiers were changed with amounts of potassium hydroxide with different acid numbers tocompare obtained results of their stability with different acid numbers and the amount of emulsifier and also potassium hydroxide with each other.

In addition to use the each one of emulsifiers, combining amount of two emulsifiers together, were compared and with various ratios in terms of stability and homogeneity as well. Formulations were prepared in the form of 20% of the solids.

Emulsion produced by oxidized polyethylene wax of Imam Port by using Kenon emulsifier

In the beginning of the work, first emulsions with oxidized polyethylene formulation of Imam port Petrochemical Complex were synthesized with acid number 23 and then the acid number 19 by using emulsifier of Kenon, in the presence of different amounts of potassium hydroxide (different weight percentages of KOH) and features of these emulsifiers have been collected in tables (3 and 4).

Table 3: Oxidized polyethylene wax with acid number 23 with different percentages of emulsifier of Kenon and potassium hydroxide

No.[(A)]	The amount of wax(weight percentage)	emulsifier of Kenon(weight percentage)	The amount of(KOH)$gr_{(KOH)}/gr_{(Wax)}$	Stability	pH
1	20	1	46/0	Unstable and heterogeneous	9-8
2	20	5	46/0	Stable and homogeneous	9-8
3	20	10	46/0	Stable and homogeneous	9-8
4	20	15	46/0	Stable and homogeneous	9-8
5	20	25	46/0	Stable and homogeneous	9-8
6	20	15	0.56	Stable and homogeneous	10-9
7	20	5	1.0	Stable and homogeneous	pH>12
8	20	10	1.0	Stable and homogeneous	pH>11
9	20	15	1.0	Stable and homogeneous	pH>11
10	20	25	1.0	Stable and homogeneous	pH=11

All formulations have 0.8 percent ethylene glycol to help to stabilize of emulsion

3-1-2-Produced emulsion with Amir Kabir Oxidized polyethylene wax by using the emulsifier of kenon with acid number 17

In general, according to emphasis of resources on the use of phenol ethoxylate nonyl emulsifier with concentrations ranging from 5 to 25 percent, necessary tests were carried out in accordance with the above formulation .The obtained results indicate that the ratios of 2, 3, and 5% by weight percentage of this emulsifier in the range of 8pH to 9, have the best stability of the emulsion.

In fact, produced product is like the two grades produced by Marcus Oil Company. In these resources, the use of Kenon emulsifier with weight percent above 5% has been pointed that with change and decrease this ratio and to 2 and 3 percent in the same pH after two months passing, the produced emulsion remains stable that is economically affordable for industrial production.

Table 4: Oxidized polyethylene wax with an acid number of 19 and different percentages of emulsifier of Kenon and potassium hydroxide

No.[(A)]	The amount of wax(Weight percentage)	Kenon emulsifier(weight percentage)	The amount of(KOH)$gr_{(KOH)}/gr_{(Wax)}$	Stability	pH
1	20	1	38/0	Unstable and heterogeneous	9-8
2	20	5	38/0	Stable and homogeneous	9-8
3	20	10	38/0	Stable and homogeneous	9-8
4	20	15	38/0	Stable and homogeneous	9-8
5	20	25	38/0	Stable and homogeneous	8
6	20	15	0.56	Stable and homogeneous	10-9
7	20	5	1.0	Stable and homogeneous	pH>10
8	20	10	1.0	Stable and homogeneous	pH>10
9	20	15	1.0	Stable and homogeneous	Ph>10

Table 5: Oxidized wax with an acid number of 17 and different percentage of emulsifier of Kenon and potassium hydroxide (KOH %)

No.	Wax amount(Weight percentage)	Kenon emulsifier(Weight percentage)	The amount of)KOH)$gr_{(KOH)}/gr_{(Wax)}$	speed stirrer round(rpm)	Stability anduniformity	The size of particles(d.nm)
1	20	2	34/0	300	Stable and homogeneous	7/190
2	20	3	34/0	500	Stable and homogeneous	9/242
3	20	5	34/0	700	Stable and homogeneous	6/129

Emulsion produced by oxidized polyethylene wax of Imam Port by using Texapon emulsifier with acid number 23 and 19

Produced product with Texapon in pH 8 to 10 rate and with 5 weight percent of emulsifier, in terms of stability, is the best among the different types of products.

Emulsion does not create the stability In the case of reducing the acidity of the environment or the percentage of emulsifier of produced product, and gradually was particles create fine sediments that will be completely two phased by passing few hours by cooling the contents of the reaction.

Data from the production of emulsion by oxidized polyethylene wax of Imam Port by using Texapon emulsifier with acid number 23 and 19 have been brought in Tables (6 and 7).

Formulations produced by oxidized polyethylene wax of Amirkabir with acid number 17 by using an alcohol ethoxylate Lauryl emulsifier with variable amounts of potassium hydroxide

As clearly is seen from Table 8, the use of alcohol ethoxylate Lauryl emulsifier with a concentration range of 2 to 15 weight percentage of this emulsifier was tested also in the range of 8 pH to 10, that all formulations were quite "two phases and were heterogeneous.

Table 6. Oxidized polyethylene wax of Imam Port Petrochemical with an acid number of 23 and the different percentage of Texapon emulsifier and potassium hydroxide

No.	The amount of wax(weight percentage)	Texapon emulsifier (weight percentage)	The amount of $(KOH)gr_{(KOH)}/gr_{(Wax)}$	Stability anduniformity	pH
1	20	3	46/0	Unstable and heterogeneous	9-8
2	20	5	46/0	Stable and homogeneous	9-8
3	20	10	56/0	Stable and homogeneous	10-9
4	20	15	0/2	Stable and homogeneous	pH>12

Table 7. oxidized polyethylene wax with an acid number of 19 and the different percentage of Texapon emulsifier and potassium hydroxide of Imam Port

No.	The amount of wax(weight percentage)	Texapon emulsifier (weight percentage)	The amount of$(KOH)gr_{(KOH)}/gr_{(Wax)}$	Stability anduniformity	pH	The size of particles(d.nm)
1	20	3	38/0	Unstable and heterogeneous	9–8	–
2	20	5	38/0	Stable and homogeneous	9–8	975/5
3	20	10	46/0	Stable and homogeneous	9–8	–
4	20	15	56/0	Stable and homogeneous	9–10	–

Table 8: Oxidized wax with acid number of 17 and different percentage of alcohol ethoxylate Lauryl emulsifier and different percentage of potassium hydroxide from Amir Kabir Petrochemical complex

No.	The amount of wax(weight percentage)	Texapon emulsifier (weight percentage)	The amount of$(KOH)gr_{(KOH)}/gr_{(Wax)}$	Stirrer speed round(rpm)	Stability anduniformity
1	20	2	34/0	300	Unstable and heterogeneous
2	20	3	34/0	500	Unstable and heterogeneous
3	20	5	34/0	700	Unstable and heterogeneous
4	20	10	46/0	500	Unstable and heterogeneous
5	20	15	0/1	300	Unstable and heterogeneous

Produced emulsions with formulation with oxidized polyethylene wax ofAmir Kabir with acid number of 17 and using different weight percentages of a mixture of two emulsifiers of alcohol ethoxylate Lauryl and Kenon with different weight percentage of KOH

Finally, produced emulsion in Amir Kabir Petrochemical with polyethylene wax based formulation with acid number 17 and by using different weight percentages of a mixture of emulsifiers of alcohol ethoxylate Lauryl and Kenon was evaluated in the presence of different combination percentage of potassium hydroxide. Features of this type of emulsion and stability or lack of stability of them have been brought in Table 9.

Table 9. Oxidized wax with acid number 17 and mixture percent of two emulsifiers of Kenon and Lauryl alcohol ethoxylate and different percentage of potassium hydroxide

No.	The amount of wax(weight percentage)	The mixture of two emulsifiers of Kenon and Lauryl alcohol ethoxylate(weight percentage(	The amonut)KOH($gr_{(KOH)}/gr_{(Wax)}$	Stirrer speed round(rpm)	Stability anduniformity	The size of particles(d.nm)
1	20	2	34/0	300	Unstable and heterogeneous	–
2	20	3	34/0	500	Stable and homogeneous	241.3
3	20	5	34/0	700	Unstable and heterogeneous	–

Finally, some of the most stable emulsion formulations, which were quite stable for 2 months, were produced by using a wax with different acid numbers (19, 17, and 23) and using 40% of raw material (solid).

Produced Products with alcohol ethoxylate and Texapon and Kenon emulsifiers and their mixture contain formulations that were quite stable during 60 days (Table 10). All above formulations were completely stable after two months

Table 10. Some of the most stable formulations of emulsion compounds synthesized by using different percentage of combinations in the presence of different emulsifiers and their mixture

The number of formulation[(a)]	Acid number of wax	The type and amount of emulsifier (gr)	The amount of wax(gr)	The amount of potassium hydroxide 86 %(gr)	The amount of ethylene glycol(gr)	The amount of water (gr)	Rotational speed of stirrer (rpm)	pH
1	17	Kenon ،2	40	0.68	0.8	56.52	500	8–10
2	17	Kenon ،3	40	0.68	0.8	52.55	500	8–10
3	17	Kenon ،5	40	0.68	0.8	53.52	500	8–10
4	19	Texapon ،5	40	0.76	0.8	53.44	–	–
5	17	Kenon+total، 3	40	0.68	0.8	55.52	–	–

Investigate the relationship between the amount of potassium hydroxide and PH of made emulsions

Investigate the relationship between the amount of used potassium hydroxide and the pH of emulsions made by PE waxes with acid numbers 19 and 23 and in the presence of emulsifiers of TEXAPON and KENON showed that the pH is increased by high levels of potassium that it is completely predictable and reasonable due to the alkaline environment, (Fig 1 A, B, C, D).

Above diagrams show the use of two acid numbers (19 and 23) and two surfactants of Texapon and Kenon. According to the diagrams and conclusions made from them can be interpreted that PH value increases with increasing potassium hydroxide in all four above diagrams that this absolutely "is evident in two different acid numbers and two different used surfactants.

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As a result, whatever the pH of produced product goes higher, our produced emulsion becomes as clot or gel that this is an indicator that the formed emulsion is corrupted.

Investigate the relationship between surfactant concentration and characteristics of formed emulsion

Small changes are obtained in pH of emulsions by changing the amount of surfactant (pH becomes less) and steady and uniformity of emulsions can be changed. Figs 2 (A, B, C, D) show the diagrams of these changes

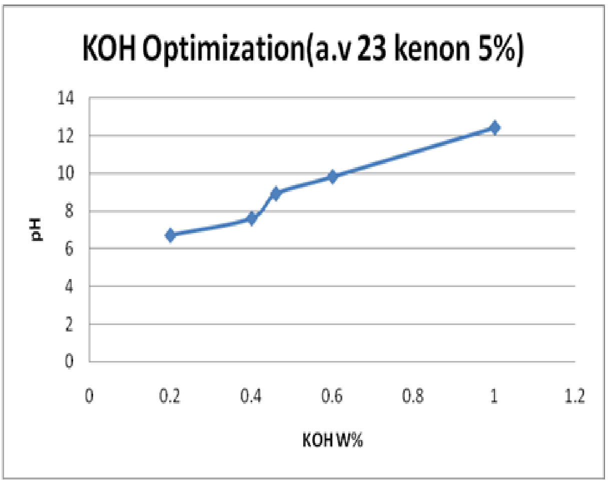


Fig. 1a. pH changes of made emulsions by changing the amount of used potassium hydroxide (used surfactants: Kenon 5%, polyethylene wax with acid number 23).

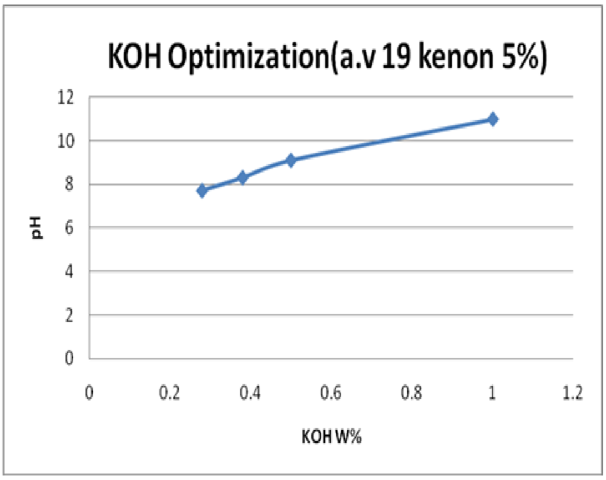


Fig. 1b. pH changes of made emulsions by changing the amount of used potassium hydroxide (used surfactants: Kenon 5%, polyethylene wax with acid number 19).

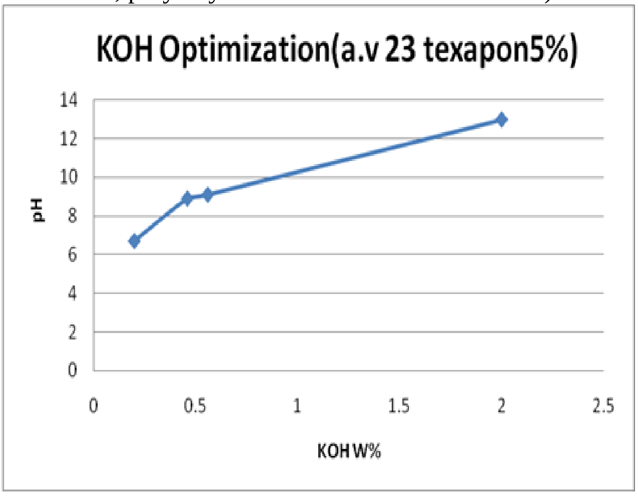


Fig. 1c. pH changes of made emulsions by changing the amount of used potassium hydroxide (used surfactants: Kenon 5%, polyethylene wax with acid number 23).

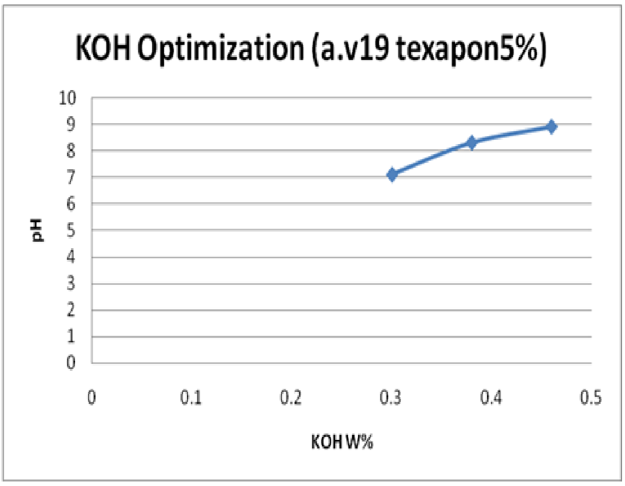


Fig. 1d. pH changes of emulsions made by changing the amount of used potassium hydroxide (used surfactant: Texapon 5%, polyethylene wax with acid number 19).

According to diagrams of Figs of 2-A and B,that shows different percentages of nonyl phenol ethoxylate Emulsifier (Kenon) in (19 and 23) acid number with amount of (1 and 0.38) percentage of potassium hydroxide, general pH of this product is between 5 to 7.It can be concluded that whatever the concentration of emulsifier of kenon goes higher, pH of produced emulsions comes down that means it goes towards acidification that this reason in the high concentration can cause that produced emulsifiers become unstable and the two-phases. So a specified percentage of this type of emulsifiers should be used. But it can be stated that about the use of TEXAPON emulsifier in different concentrations according to diagram of Figs of. 2-C and D,; it's pH is variable in the range of 7 to 9 and whatever the concentration of this type of surfactant goes higher, produced emulsifier pH goes lower and remains in the same pH range between 7 and 9 and became lower by increasing surfactant pH too.

Comparison of the results of data of DLS test for ratios of 2, 3, and 5% of emulsifier of kenon:

It can be concluded by comparing the z-Average (d.nm) data from DLS test results for ratios of 2, 3, and 5% of emulsifier of Kenon in the below diagram , as can be seen on the red arrow, increasing the amount of emulsifier in theory form causes to reduce the size of the particle size due to increase in micelles number.

But agitation force will be effective in the average concentrations of emulsifier in addition to the emulsifier concentration, in this sense that agitator causes the micelles deal with each other and merge of them.

Particles stick together, diameter of the particle size increases due to the difference of tension between micelle surface and the environment of emulsion, in average concentrations of 3% of emulsifier of Kenon.

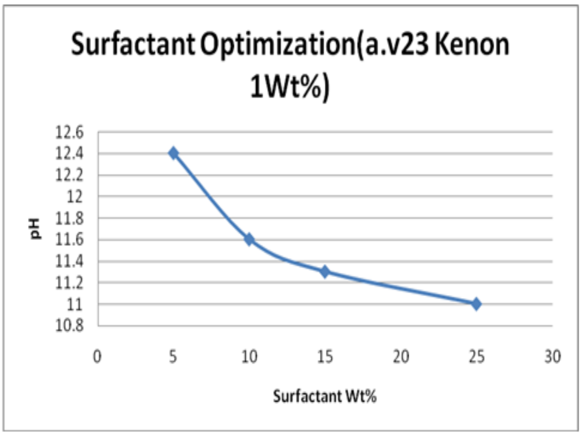


Fig. 2a. the relationship between surfactant concentration and pH of emulsion results from Kenon emulsifier with weight percentage of 1.0% with acid number 23.

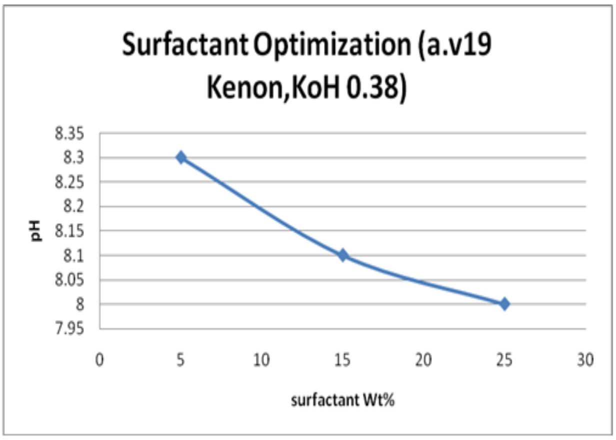


Fig. 2b. the relationship between surfactant concentration and pH of emulsion results from Kenon emulsifier with wax with acid number 19.

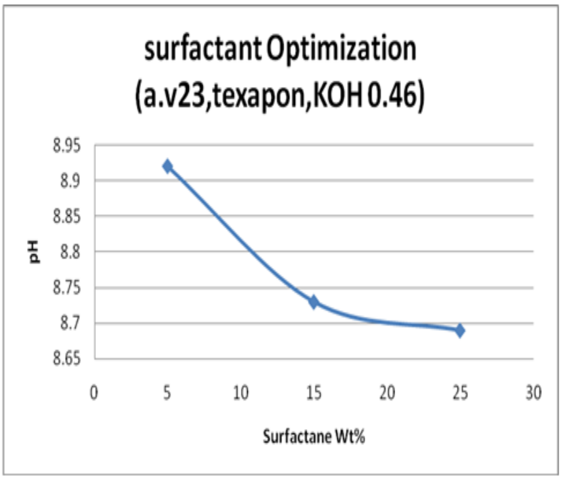


Fig. 2. the relationship between surfactant concentration and pH of emulsion results from Texapon emulsifier with wax acid number 23.

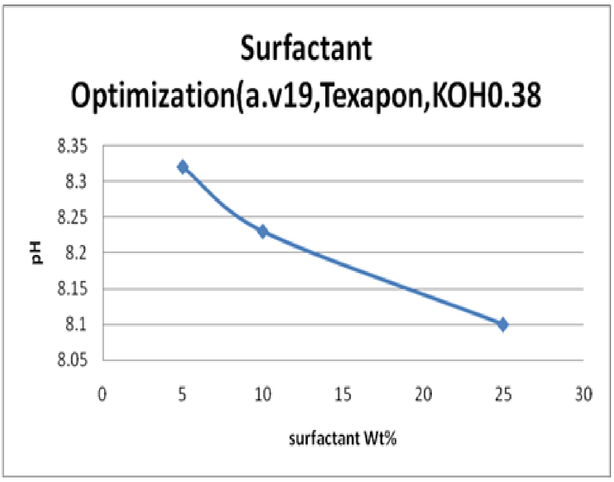


Fig 2 (d) : the relationship between surfactant concentration and pH of emulsion results from Texapon emulsifier with wax acid number 19.

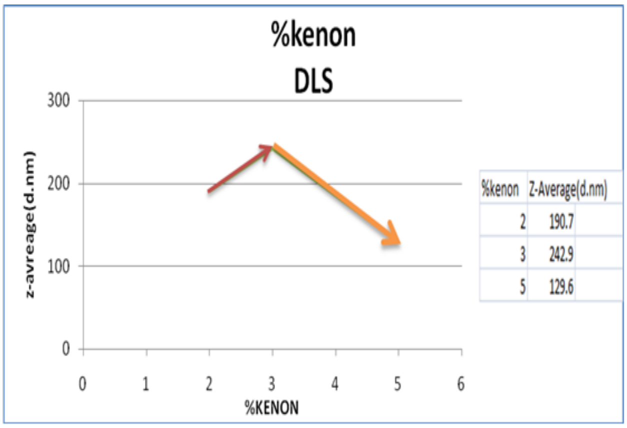


Fig. 3. Comparison of results of DLS test for an emulsifier of Kenon with relative weight percentages 2, 3, and 5

In addition, in orange flash in using the of relatively high concentrations of emulsifier of Kenon, in addition, that the number of micelles is much increased, as a result, also decreases the average number of radicals in micelles and also monomer in the micelle, which this matter causes to reduce the diameter of the particles, which is completely specified in the data of results of DLS test.

Nearness of surface tension of micelle and the emulsion's media causes that agitation force causes to simultaneous occurrence of the phenomenon of integration and separation of micelles.

Comparison the Poly Dispersity Index of data from DLS results for ratios of 2, 3, and 5% of emulsifier of Kenon

It can be concluded from comparison of PDI data of DLS results for ratios of 2, 3, and 5% of emulsifier Kenon as can be seen in the below diagram, that emulsion living conditions are less at low concentrations of emulsifier, for example in 2% concentration, using of emulsion kenon of other particles is closer together, and it's because of that the amount of sites (micelles) is less for emulsion that distribution increases by increasing of emulsifier.

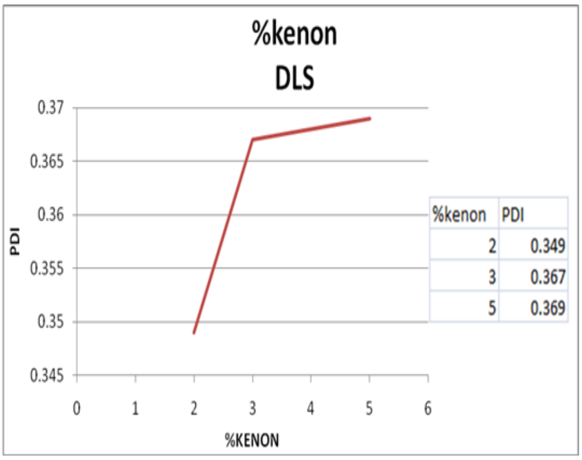


Fig 4: Comparison of test results of PDI for an emulsifier of Kenon with ratio (2, 3, 5) percent

Comparison of mixture of two emulsifiers (kenon and alcohols 3%), with emulsifiers (Kenon 3%) by using the results of DLS

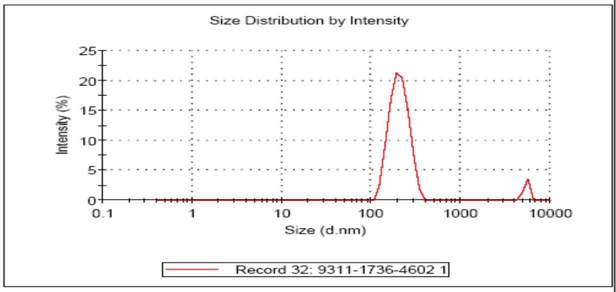
It can be concluded that the use of mixture of emulsifier of Kenon and alcohol has same diameter average of particle size with emulsifier of Kenon as in diagram of data of DLS and compare between mixture of emulsifiers (diagrams of Fig 5a and b) and emulsifier of Kenon that both of them are with ratios of 3%.As can be seen in the diagram, using two types of emulsifiers (mixture of emulsifiers) together causes to produce two types of micelles that the data show that the first peak (lower size) according to the diagram of Kenon is related to the emulsifier of Kenon and the second peak is related to the emulsifier of alcohol. The reason of this phenomenon is higher molecular weight of alcoholic emulsifier that leads to the formation the micelles, with larger in diameter. So the particle size distribution with respect to kind frequency in a mixed system will be higher that shows consequences of this phenomenon.

As it can be seen in diagrams of Figs of (6 a and b),it can be concluded of the comparison of the two emulsifiers of Texapon and Kenon with the same percentages in the synthesis of emulsion that particles with higher diameter in Texepon due to higher molecular weight (more carbon number) for this emulsifier causes that formed micelle has higher diameter than the use of emulsifier of Kenon then it can be concluded that the use of the emulsifier of Texapon obtains larger particle sizes than the emulsifier of Kenon.

Results

Z-Average (d.nm): 242.9
PdI: 0.367
Intercept: 0.961
Cumulants Fit Error: 0.00168
Multimodal Fit Error: 0.00299
In Range: 97.7
Result quality : Refer to quality report

	Diam. (nm)	% Intensity	Width (nm)
Peak 1:	207.6	94.9	49.13
Peak 2:	5324	5.1	375.8
Peak 3:	0.000	0.0	0.000



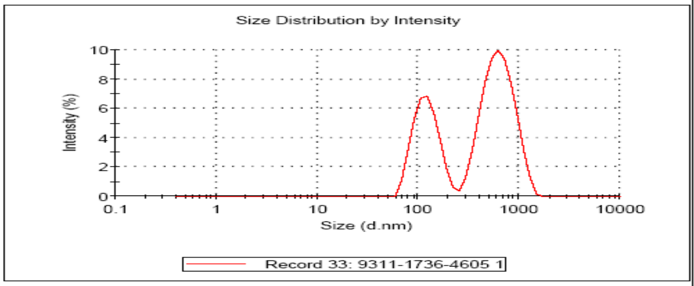
Size d.nm	Intensity %	Size d.nm	Intensity %
0.4000	0.0	68.06	0.0
0.4632	0.0	78.82	0.0
0.5365	0.0	91.28	0.0
0.6213	0.0	105.7	0.0
0.7195	0.0	122.4	2.5
0.8332	0.0	141.8	9.2
0.9649	0.0	164.2	16.8
1.117	0.0	190.1	21.2
1.294	0.0	220.2	20.4
1.499	0.0	255.0	15.0
1.736	0.0	295.3	7.7
2.010	0.0	342.0	2.0
2.328	0.0	396.1	0.0
2.696	0.0	458.7	0.0
3.122	0.0	531.2	0.0
3.615	0.0	615.1	0.0
4.187	0.0	712.4	0.0
4.849	0.0	825.0	0.0
5.615	0.0	955.4	0.0
6.503	0.0	1106	0.0
7.531	0.0	1281	0.0
8.721	0.0	1484	0.0
10.10	0.0	1718	0.0
11.70	0.0	1990	0.0
13.54	0.0	2305	0.0

Fig. 5a. DLS emulsifier of 3% KENON.

Results

Z-Average (d.nm): 241.3
PdI: 0.516
Intercept: 0.971
Cumulants Fit Error: 0.00250
Multimodal Fit Error: 0.00210
In Range: 94.1
Result quality : Refer to quality report

	Diam. (nm)	% Intensity	Width (nm)
Peak 1:	649.3	64.5	228.5
Peak 2:	123.8	35.5	36.42
Peak 3:	0.000	0.0	0.000



Size d.nm	Intensity %	Size d.nm	Intensity %
0.4000	0.0	68.06	1.1
0.4632	0.0	78.82	3.1
0.5365	0.0	91.28	5.3
0.6213	0.0	105.7	6.7
0.7195	0.0	122.4	6.8
0.8332	0.0	141.8	5.7
0.9649	0.0	164.2	3.9
1.117	0.0	190.1	1.9
1.294	0.0	220.2	0.7
1.499	0.0	255.0	0.4
1.736	0.0	295.3	1.3
2.010	0.0	342.0	3.2
2.328	0.0	396.1	5.6
2.696	0.0	458.7	7.8
3.122	0.0	531.2	9.4
3.615	0.0	615.1	10.0
4.187	0.0	712.4	9.3
4.849	0.0	825.0	7.7
5.615	0.0	955.4	5.5
6.503	0.0	1106	3.1
7.531	0.0	1281	1.2
8.721	0.0	1484	0.2
10.10	0.0	1718	0.0
11.70	0.0	1990	0.0
13.54	0.0	2305	0.0

Fig. 5b. DLS mixture of two emulsifiers (kenon and alcohol of 3%).

CONCLUSION

Valuable research results are obtained about the synthesis of polyethylene oxidized emulsion by conducting this research thatit deserves reflection. The use of nonyl-phenol ethoxylate emulsifier or Kenon in the ratios of 2, 3, and 5% gives the best stability of the emulsion. In addition, the use of emulsifier of Kenon with a ratio of 5%, gives smaller particle size of emulsion than the use of other two percentage amount means 2, and 3%.In fact, as much the percentage amount of emulsifier is greater, the particle size becomes smaller (though, it seems this amount of ice has the optimum range that in this research there was no time and opportunity for further analysis.

The use of emulsifier of Texapon has larger particle size due to the higher molecular weight (more carbon number) than the emulsifier of Kenon. However, other results are listed as follows.

Results

Z-Average (d.nm): 975.2

PdI: 0.780

Intercept: 0.987

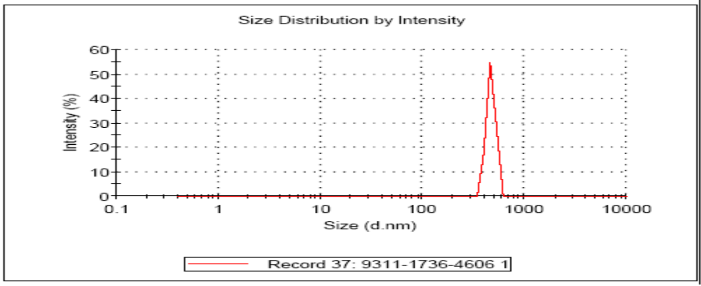
Cumulants Fit Error: 0.0167

Multimodal Fit Error: 0.0283

In Range: 97.6

	Diam. (nm)	% Intensity	Width (nm)
Peak 1:	467.5	100.0	45.48
Peak 2:	0.000	0.0	0.000
Peak 3:	0.000	0.0	0.000

Result quality : Refer to quality report



Size d.nm	Intensity %	Size d.nm	Intensity %
0.4000	0.0	68.06	0.0
0.4632	0.0	78.82	0.0
0.5365	0.0	91.28	0.0
0.6213	0.0	105.7	0.0
0.7195	0.0	122.4	0.0
0.8332	0.0	141.8	0.0
0.9649	0.0	164.2	0.0
1.117	0.0	190.1	0.0
1.294	0.0	220.2	0.0
1.499	0.0	255.0	0.0
1.736	0.0	295.3	0.0
2.010	0.0	342.0	0.0
2.328	0.0	396.1	17.8
2.696	0.0	458.7	54.6
3.122	0.0	531.2	27.6
3.615	0.0	615.1	0.0
4.187	0.0	712.4	0.0
4.849	0.0	825.0	0.0
5.615	0.0	955.4	0.0
6.503	0.0	1106	0.0
7.531	0.0	1281	0.0
8.721	0.0	1484	0.0
10.10	0.0	1718	0.0
11.70	0.0	1990	0.0
13.54	0.0	2305	0.0

Fig. 6.a DLS using the emulsifier of Texapon 5% in emulsion

Results

Z-Average (d.nm): 129.6

PdI: 0.369

Intercept: 0.937

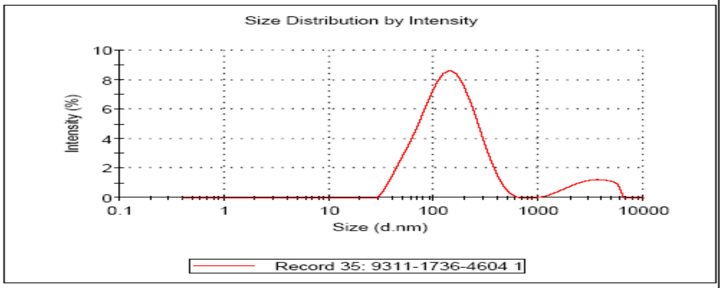
Cumulants Fit Error: 0.00139

Multimodal Fit Error: 0.00141

In Range: 97.4

	Diam. (nm)	% Intensity	Width (nm)
Peak 1:	154.9	89.8	90.10
Peak 2:	3282	10.2	1260
Peak 3:	0.000	0.0	0.000

Result quality : Refer to quality report



Size d.nm	Intensity %	Size d.nm	Intensity %
0.4000	0.0	68.06	4.7
0.4632	0.0	78.82	5.8
0.5365	0.0	91.28	6.8
0.6213	0.0	105.7	7.8
0.7195	0.0	122.4	8.4
0.8332	0.0	141.8	8.6
0.9649	0.0	164.2	8.4
1.117	0.0	190.1	7.6
1.294	0.0	220.2	6.6
1.499	0.0	255.0	5.3
1.736	0.0	295.3	3.9
2.010	0.0	342.0	2.7
2.328	0.0	396.1	1.6
2.696	0.0	458.7	0.8
3.122	0.0	531.2	0.3
3.615	0.0	615.1	0.1
4.187	0.0	712.4	0.0
4.849	0.0	825.0	0.0
5.615	0.0	955.4	0.0
6.503	0.0	1106	0.1
7.531	0.0	1281	0.2
8.721	0.0	1484	0.4
10.10	0.0	1718	0.6
11.70	0.0	1990	0.8
13.54	0.0	2305	1.0

Fig. 6b. DLS using the Kenon 5% in emulsion

Using of lauryl-alcohol ethoxylate emulsifier in any ratio leads to instability and two phasing of the emulsion.

Stirring with high rotational speed during emulsifying, causes to become smaller the size of particles size and also stability of the emulsion.

We should use of the stirring power round for production and making the emulsion especially when we want to add water and potassium hydroxide to the wax and surfactant mixture, until synthetic emulsion does not have viscose mode and does not become two phases.

The stirrer speed round should be used when the emulsion was formed, for more stable emulsion.

Use a mixture of two emulsifiers of kenon and alcohol, produces good and stable emulsion with acceptable particle sizes than total of 3.

The great use of potassium hydroxide leads to goes up the emulsion pH that this matter causes becomes the emulsion as a clot or a gel.

Using a high percentage of concentration of emulsifiers causes to become lower the pH. This matter causes that the emulsion becomes unstable and two-phases.

The effect of stirring has a large impact on the size of the emulsion particles and stability of emulsion.

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