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Phosphatide Concentrates of Vegetable Oils as a Lubricant Additive to Emulsion-Clay Drilling Fluid

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ABSTRACT: Today, in the world, much attention is paid to expanding the raw material base and the production of natural biologically active additives (BAA), which include phospholipids. The main sources of phospholipids for food and technical purposes are vegetable oils, the production of which increases from year to year. The article provides an overview of stabilizers and lubricating agents added to drilling fluids used when drilling wells in conditions of productive horizons on the territory of the Republic of Uzbekistan. The results of a theoretical study of the properties of phosphatide concentrates as potential lubricating additives for clay drilling muds are also reflected. Based on the results of the analytical study, recommendations are given to improve the technological efficiency of the drilling fluids used and chemical additives to them.

KEY WORDS: drilling fluid, phospholipid, lecithin, bottom hole assembly (BHA), lubricant.

I. INTRODUCTION

The intensive development of engineering and technology in the chemical, food and other industries is closely related to the use of surface-active substances (surfactants) of various nature, which can improve the efficiency of processes, expand their scope and reduce material and energy costs.

The global trend in the production and expansion of their applications is aimed at replacing synthetic surfactants with natural ones, which is associated with chemical, environmental and food safety.

Phospholipids are one of the important concomitant components of triacylglycerides in vegetable oils, in particular cottonseed oils. Their compositions and properties are characterized by the presence of substances that are similar in nature and depend on the quality of the oilseed raw material and the changes that occur both during the extraction process and during the subsequent processing of vegetable oils.

The biological and surface-active properties of phospholipids, in particular, those obtained from cottonseed oils, dictate the importance of the production of phosphatide concentrate and its application in various sectors of the economy.

Important properties of phospholipids that determine their consumption as an independent product are their surface-active properties, polarity, polarizability, as well as the ability to associate and micelle formation in non-polar and low-polar solvents.

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They are capable of changing the phase and energy interactions at the interfaces of the polar and nonpolar phases. The presence of such activity for phospholipids is due to their chemical structure, polarity and polarizability, as well as external factors: temperature, nature of the medium (solvent), concentration and feature (type) at the phase boundary.

II. EXPERIMENTAL RESULTS

We have studied the quality indicators of raw and hydrated cottonseed oils using microwave radiation under the following conditions: processing time - 2 minutes, power - 300 W, the amount of added water - 4% of the oil mass.

Table 1: Physical and chemical parameters of crude and hydrated cottonseed oils obtained in the traditional way (control) and using microwave radiation

Name of oil index	Raw cottonseed oil	Hydrated Cottonseed Oil	
		Traditional way (control)	Using microwave radiation
Chromaticity, in cr.un. at 35 yellow	74,5	68,9	62,4
Acid number, mg KOH/g	4,52	4,43	4,35
Content, %			
phospholipids	2,24	0,57	0,31
unsaponifiables	1,28	0,98	0,82
moisture	0,2	0,15	0,11
oxidation products (total)	0,51	0,45	0,41
carbohydrates (total)	0,055	0,038	0,022

From Table. 1 it can be seen that with microwave radiation, the quality indicators of hydrated oil do not deteriorate compared to oil obtained in the traditional way. On the contrary, the color of hydrated cottonseed oil obtained using microwave radiation is 6.5 kr. units at 35 yellow is lower than the color of the oil obtained in the traditional way. Also, in hydrated oil, the content of phospholipids decreases by 0.26%, unsaponifiable substances - by 0.16%.

Thus, the developed high-intensity technology of cottonseed oil hydration using microwave radiation, in contrast to the traditional technology (instead of 5-6 hours of coagulation (exposure) of phospholipids), makes it possible to form large phosphatide flakes in 2-3 minutes and separate them using a separator. Microwave radiation affects all types of polarization (from electronic to micellar and structural). Under the action of an electromagnetic field, a local field arises that polarizes the active groups of cottonseed oil phospholipids, which depend on the dynamic electronic effects of these compounds. All this intensifies the coagulation of phospholipids by accelerating the formation of their association and micellization. Moreover, experiments have shown that the most effective intensification of the process of hydration of cottonseed oil occurs when the contact of oil with water is carried out directly in the zone of a rotating electromagnetic field. At the same time, it was found that microwave radiation does not cause any undesirable changes in hydrated cottonseed oil and phospholipids derived from it.

Unlike traditional technology, hydration of cottonseed oil using microwave radiation is carried out under the influence of new factors (super high-frequency electromagnetic forces, volumetric heating, etc.).

Lecithin is an effective natural emulsifier from the phospholipid family, obtained from vegetable oils and its quality determines the areas of its application.

As shown by the results of laboratory and pilot studies of the hydration process of pressing and extraction cottonseed oils, the resulting phospholipids contain a residual amount of toxic gossypol, chlorophyll and their derivatives. Therefore, they are recommended to be used for technical purposes.

In table. 2 shows the main indicators of the obtained lecithins from cottonseed oil.

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Table 2: Main indicators of liquid and defatted lecithins obtained from cottonseed oil

Name of indicator	GOST R 32052-2013 (control)		Cotton lecithin technical	
	liquid	skimmed	liquid	skimmed
Mass fraction, %: of substances insoluble in acetone	at least 60,0	at least 95,0	63,8	98,2
of substances insoluble in toluene	no more 0,30		0,16	0,15
of moisture and volatile substances	no more 1,0		0,9	0,6
of gossypol and its derivatives	not defined		0,3	0,2
Color number of 10% solution in toluene, mg of iodine	no more 80,0		78,0	74,0
Acid number, mg KOH/g	no more 36,0		27,2	24,3
Peroxide number, mmol active oxygen/kg	no more 10,0		3,8	4,3
Viscosity at 25°C, Pa·s	no more 12	not standardized	10,2	not defined
Mass fraction of solvent, %	not defined		-	-
Toxic elements, mg/kg: lead	no more 0,1		0,015	0,013
cadmium	no more 0,05		0,008	0,007
mercury	no more 0,05		0,004	0,002
arsenic	no more 0,1		0,006	0,004

From Table. 2 shows that in terms of their main physicochemical and toxicological indicators, liquid and fat-free lecithins obtained from cottonseed oil do not meet the requirements for food products. Therefore, this makes them suitable for technical use. This is confirmed by the presence of gossypol and its derivatives in liquid and defatted lecithin obtained from cottonseed oil.

Due to its emulsifying and viscosity-lowering properties, technical liquid lecithin derived from cottonseed oil can be effectively used to reduce the viscosity of heavy oils, before transporting them through pipelines and in the preparation of clay drilling fluids as a lubricating additive.

III. PROPOSED METHODOLOGY AND DISCUSSION

It is known that in order to lubricate the BHA, it is necessary to add so-called lubricants to the composition of the drilling fluid used, i.e. lubricant agent. Traditionally, the lubricating agent should mainly contain substances that reduce adhesion.

Currently, in world and domestic practice, several dozen types of lubricants are used as additives to drilling fluids, which are obtained on the basis of synthetic and natural substances, in particular, based on organosilicon, fatty acids, vegetable oils, etc. World experience shows that when drilling wells, the variety of lubricating agents added to the drilling fluid is limited by the presence in them mainly of graphite, saponified tall pitch and SMAD. Statistics show that the use of lubricants with a similar content has annual consumption values within 3% of the total requirements for components (materials, reagents) of drilling fluids.

There is also a well-known world and domestic experience in the use of oil as a lubricant. It is worth noting here that the indicator of oil consumption as a lubricating additive in the drilling fluid has a numerical value of about 10 percent, which results in a sufficient environmental factor of environmental pollution with drilling waste and, in general, an increase in the cost of the drilling process itself.

Increasing the lubricity of the drilling fluid is necessary to reduce friction and drag forces. Despite the prevalence of the above-mentioned lubricants, technological complications are observed when using them. Technological complications include tightening, landing, sticking of the drilling tool. This leads to the expenditure of large funds and time to eliminate the above complications.

Thus, it should be noted that the traditionally used additives in the drilling fluid as lubricating additives are not sufficiently effective and cost-effective in domestic practice, and therefore there are improvements.

In order to increase the economic and technological efficiency of drilling operations, especially when drilling wells with a depth of at least 3 km, the author initiated a study to determine the potential for effective use of phosphatide

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concentrates of vegetable oils produced in the Republic of Uzbekistan as a lubricant additive. and this paper presents some of the results of this theoretical and analytical study.

The main object of study in this work is the family of vegetable oil phospholipids, which mainly consist of lecithin (36-38%) and cephalin (61-62%). In addition, the composition of phosphatides contains a small amount (1.5-2%) of inositol phosphatides.

It is worth noting that lecithin is an ester of glycerol and represents two hydroxyls ethified with fatty acids, and a third phosphatidic acid. It should be mentioned that it contains one valency of phosphoric acid eified with choline.

As noted above, lecithin is considered a natural surfactant and therefore has a good emulsifying ability.

Hydrated phospholipids include: phosphatidylcholines and their lyso derivatives, phosphatidylethanolamines, phosphatidylinositols, phosphatidic and polyphosphatidic acids, and non-hydratable phosphorus-containing substances of a non-lipid nature, acidic forms of phosphatides (phosphatidic and polyphosphatidic acids), lipo-derivative compounds (lipophosphatidic acids, lipophosphatidylserines, lysophosphatidylethanolamines), glycolipids complex structure, salts of acidic phosphatides with metals, compounds of polyphosphatidic and phosphatidic acids with sterols and aliphatic alcohols [1].

The fatty acid composition of non-hydratable phosphatides differs from that of hydrated fractions by a high content of saturated fatty acids.

Phosphatides, a non-hydratable group, can be characterized with a significantly greater presence of ash in them. This fact confirms the presence in them of compounds that have acidic properties and the ability to actively interact with metals. The total share of the content of alkali group metals in hydrated and non-hydrated phospholipids, as a percentage, is 0.47-0.54%, and a significant proportion of these metals is magnesium and calcium.

In nature, non-hydratable and hydrolysable (with alkalis and acids) gossyphospholipids have been identified.

Previously, in [2, 3], attempts were made to remove gossypol and its derivatives from cottonseed oil and its micelles. However, these methods and technologies, due to low efficiency, were not fully implemented at the oil and fat enterprises of the country.

It is known that the content of phospholipids in raw pressed cottonseed oil ranges from 1.48-2.80%.

Also in other scientific papers in this direction, the methods of hydration of pressing and extraction cottonseed oils obtained by periodic and continuous methods are outlined. To implement the latter, a special hydrator-dispenser of the ejector type is proposed, which provides a high degree of dispersion of water in cottonseed oil with its simultaneous dosing. After a long exposure, the hydrated oil is sent to a continuously operating settling tank or a continuously operating horizontal centrifuge of the NOGSH type. Under optimal conditions of hydration of cottonseed oil, its acidity is reduced by up to 0.3%, and its color is reduced by 10 red units.

Unfortunately, this method of hydration of cottonseed oils has not yet found its practical application due to significant material and energy costs and losses.

Later, the famous scientist Rzhekhin V.P. developed a continuous method for hydrating vegetable oils with small amounts of water to obtain high-quality phosphatides by their combined degreasing and dehydration with acetone, as well as obtaining them in powder form. However, the practical implementation of this method was carried out in the processing of sunflower and soybean oils.

IV. CONCLUSION

As a result of the analysis of previously published works, it was revealed that the proven hydration methods, which are presented to the public in the form of different technological schemes and modes, provide incomplete extraction of the entire complex of phosphorus-containing groups of substances from the oil, since the degree of excretion of phosphatides is determined not only by them, but also by the state of their hydrophilicity, i.e. the presence in the oil of their hydrated and non-hydrated forms.

In [4], a method for steam hydration of sunflower oil using a new design of a steam ejector-hydrator is defended. When using this technology for the hydration of cottonseed oils, due to the high temperature, new types of gossypol and chlorophyll derivatives will be formed, which is undesirable for the production of oils for food purposes.

Also, there are methods for obtaining phosphatide-containing lard and hydrogenated phospholipids, purification of vegetable oil micelles from carbohydrates and metal ions with a citrate reagent, and hydration of phospholipids from press and extraction oils, for example, sunflower.

Recently, a number of works [5, 6] have been devoted to the use of phospholipids in various food and other products, where it is necessary to increase the biological value and emulsifying properties.

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Articles have been published [7] devoted to the study of the effect of chemical reagents on the stability of compounds of phospholipids with unsaponifiable lipids and the mechanism of their hydration, as well as a method for obtaining phospholipids with increased biological activity.

In Uzbekistan, the main type of processed oilseeds are cottonseeds, which contain poisonous ie. toxic gossypol and its derivatives. Therefore, during the hydration of raw cottonseed oils, this substance passes without much difficulty into the composition of the resulting phospholipids, which makes it possible to use them only for technical purposes. According to the well-known technology of hydration of cottonseed oils, up to 50% of triacylglycerides, i.e. neutral fats capable of lubricating various surfaces of moving mechanisms and systems. With this in mind, we have studied the possibility of using technical phospholipids together with triacylglycerides in the composition of emulsion clay drilling fluids, which, in our opinion, allows us to expand the scope of their application.

Thus, the use of local raw materials in the production of emulsion drilling fluids makes it possible to reduce the cost of the obtained reagents and improve the quality of drilling operations.

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