Ljiljana Marinić Pajc, Jasenka Petran

ISSN 0350-350X
GOMABN 39, 1, 35-44
Izlaganje sa znanstvenog skupa/Conference paper
UDK 622.243.24 : 622.24.063 : 665.334.94 : 576.343

RAZVOJ FORMULACIJE MAZIVA ZA HORIZONTALNE BUŠOTINE NA OSNOVI REPIČINOG ULJA

Sažetak

Mazivo za horizontalne bušotine primjenjuje se u isplakama za povećanje njezinih podmazujućih svojstava prilikom provedbe postupaka bušenja. Dobro podmazujuće svojstvo isplake je vrlo značajno zbog znatne uštede vremena, produženja trajnosti opreme, smanjivanja broja manevara i isplativije provedbe ukupnog postupka bušenja.

Primjenom ekoloških povoljnih sirovina u mazivima moguće je spriječiti zagađivanje okoliša (tla i vode). Repičino ulje spada u grupu baznih ulja prihvatljivih za okoliš te osim lake i relativne brze biorazgradnje ima i druga povoljna svojstva: dobru mazivost, visoku viskoznost, dobru prionljivost na metalne površine i vrlo dobru podnošljivost na opterećenja. Loša primjenska svojstva repičinog ulja: ponašanja na visokoj i niskoj temperaturi, hidrolitička stabilnost te svojstvo pjenjenja moguće je poboljšati ugradnjom odgovarajućih aditiva.

UVOD

Pri horizontalnom bušenju (slika 1), zbog većeg zakrivljenja dijela kanala, pojavljuje se veće trenje bušećeg alata o stijenke kanala bušotine nego kod uspravnih ili blago zakrivljenih bušotina. Isplaka je medij namijenjen ispiranju bušotine tijekom njezine izrade, odnosno tijekom izvođenja radova u njoj. U isplake se ugrađuju aditivi, tj. poboljšivači svojstva isplake kao što su: površinski aktivne tvari, emulgatori, podmazivači, inhibitori korozije, materijali za čepljenje i dr. Sve veće dubine bušenja, više temperature i tlakovi, ali i složenija i preciznija bušeća oprema zahtijevaju bolja svojstva isplaka tako da područja aditiva za isplake predstavljaju kontinuirani razvojno-istraživački rad u koji su uključeni i kemičari. Smanjenje trenja može se postići odabirom i primjenom isplake s dobrim svojstvima podmazivanja. Sa svrhom podmazivanja razvijeni su, a i nadalje se razvijaju i istražuju aditivi za maziva za horizontalne bušotine. Slika 2 prikazuje različit efekt podmazivanja komercijalnih maziva A, B i C u isplaci u usporedbi s mazivošću isplake bez dodatka aditiva.

MAZIVA NA OSNOVI OBNOVLJIVIH IZVORA

Masti i ulja biljnog ili životinjskog porijekla najstariji su izvori i imaju dugu primjenu kao osnova za različita maziva, ali zbog poglavito ograničene stabilnosti na temperaturu takva maziva su ograničene primjene. Razradom prerade nafte tijekom prve polovice 20. st. zbog sve zahtjevnije i raznolikije primjene istiskuju ih maziva na osnovi mineralnih ulja. Poznato je da danas dio primjene, dakle i tržišta pokrivaju i maziva na osnovi sintetičkih ulja.

Sve se više razvija svijest o štetnosti policikličkih aromatskih spojeva (PCA) i sumpora prisutnih u mineralnim uljima na ljudsko zdravlje i okoliš. Po nekima, sumpor je veći zagađivač okoliša nego izgaranjem ugljikovodika nastali CO_2 (efekt staklenika).

Maziva na osnovi obnovljivih izvora, tj. masti i ulja ubrajaju se više ili manje u specijalna maziva. Sa viješću zaštite okoliša i ljudskog zdravlja masti i ulja kao obnovljiv izvor postaju aktualne i posvećuje im se sve veća pozornost i ispituje mogućnost što brojnije supstitucije za mineralna ulja, a posljedica toga je promjena cjelokupnog sastava maziva. Prirodne masti i ulja gotovo da i ne sadrže sumpor, biorazgradljive su, za razliku od mineralnih i sintetičkih ulja, a poznato je njihovo iznimno dobro svojstvo podmazivanja. Valja naglasiti da isključivi povratak obnovljivim izvorima, u ovom slučaju mastima i uljima, nije moguć.

ADITIVI U MAZIVIMA ZA HORIZONTALNE BUŠOTINE

I u sama maziva biljne ili životinjske, fosilne ili sintetičke osnove ugrađuju se razni aditivi, koji će mazivu omogućiti da zbog pozitivnog svojsta podmazivanja, radi čega se i dodaju u isplake, ne narušava fizičko-kemijska i reološka svojstva isplake. Zbog tog razloga je sastav maziva sa svrhom podmazivanja isplake vrlo složen. Kada se mazivo, pretežito organska komponenta, dodaje u vodene isplake koje su i same vrlo različitih sastava, nezaobilazni su emulgatori, disperzanti, antipjenići, a zbog najčešće vanjskih uvjeta skladištenja na niskim temperaturama i depresanti stiništa.

EKSPERIMENTALNI DIO

Cilj istraživanja je izrada formulacije maziva za horizontalne bušotine odgovarajućeg sastava aditiva koje će se koristiti u isplakama u količini 2 i 3% mas. jednako kao i komercijalno mazivo B. Djelotvornost mora biti jednaka ili bolja od komercijalnog maziva B, uz zahtjev da se ne narušavaju fizikalno-kemijski i reološki parametri isplake.

Vlastita formulacija maziva HORMA načinjena je od oko 95% sirovina domaćeg porijekla. Sirovinski sastav formulacije HORMA je ekološki i toksikološki prihvatljiv, postupak pripreme je jednostavan i ne zahtijeva specijalnu opremu (mješalica, grijanje do 60°C). U mazivo za horizontalne bušotine ugrađeni su: derivat rafinerijske prerade nafte, ulje repice, emulgator, antipjenić i depresant stiništa sintetiziran u INA-SSRI.

DISKUSIJA REZULTATA

Testiranjem utvrđena inverzija komercijalnog maziva tj. bolje podmazivanje maziva u smanjenoj količini (2% mas. bolje od 3% mas.) nije u primjeni od osobitog značenja. Mazivo se u isplake dodaje u količini od 2% mas. što se nastoji održati tijekom izrade i rada na bušotini, a treba očekivati da je mazivo u rasponu efikasnosti podmazivanja 2 do 3% mas.

Pokazatelj djelotvornosti podmazivanja nekog maziva za primjenu pri izradi bušotina je zakretni moment pri radu alata ili parametar torzije, odnosno koeficijent trenja maziva. Što je on niže vrijednosti, mazivo ima bolje svojstvo podmazivanja. Iz slike 3 i tablice 1 vidljivo je da formulacija maziva HORMA ima osjetno niže vrijednosti koeficijenta trenja (ovisno o dodanoj količini maziva u isplaku 2 ili 3%) u usporedbi s komercijalnim mazivom B.

Mazivo HORMA ima temperaturu stiništa nižu u usporedbi s komercijalnim mazivom B te bi se moglo skladištiti i primjenjivati na nižim temperaturama (min. –30°C), (slika 3).

ZAKLJUČAK

Usporednim testiranjem komercijalnog maziva B i maziva HORMA priređenog u INA-SSRI može se zaključiti da HORMA ugrađena u isplaku gotovo ne mijenja fizikalno-kemijska i reološka svojstva isplake kao što i zahtijeva rad na bušotini budući da bi njihova znatna promjena (tablica 1) dovela do operativnih problema. Mazivost i stinište HORMA evidentno pokazuju prednost u odnosu na komercijalno mazivo B.

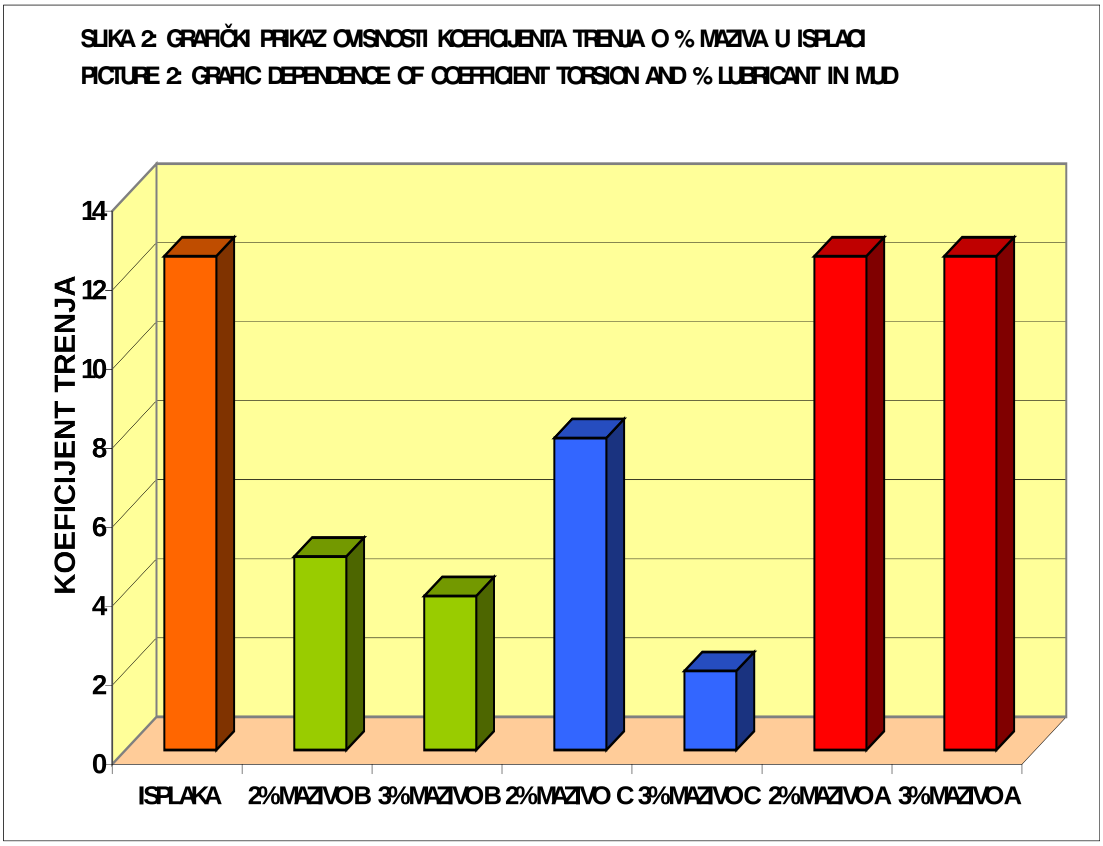
Tablica 1: Usporedba rezultata testiranja komercijalnog maziva B i HORME u isplaci
Table 1: Comparison of test results of commercial lubricant B and HORMA in the mud

		ISPLAKA/MUD	ISPLAKA/MUD + 2% MAZIVO/ LUBRICANT B	ISPLAKA/MUD+ 3% MAZIVO/ LUBRICANT B	ISPLAKA/MUD+ 2% HORMA	ISPLAKA/MUD+ 3% HORMA
miješano/stirred stajalo/left standing	min sati/hrs	30+90 16	30+120 16		30+120	30+120 16
Gustoća isplake Mud density	kg/dm^3	1,10	1,10	1,10	1,09	1,09
Filtracija API	ml	10,0	9,8	9,0	8,0	7,4
Debljina obloge API Coat thickness	mm	0,5	0,5	0,5	0,5	0,5
pH isplake/mud		9,45	9,02/9,51	9,60	8,80	8,72
Fann viskoznost	mPa.s	32	34	34,5	39	39,5
Plastična viskoznost Plastic viscosity	mPa.s	23	26	26	28	28
Granica tečenja Pour limit	Pa	9	8	8,5	11	11,5
Fann gel 10"/10	Pa	2/7	2/3	1,5/3	1,5/5	2/5
Torzija/Torsion	inch/pound (m/kg)	16,6 (0,19)	10,8 (0,12)	13,3 (0,15)	7,0 (0,08)	3,1 (0,03)

Slika 1: Shematski prikaz horizontalnih bušotina
Figure 1: Horizontal well outline

smooth wall expansion top target layer centralizers previously made openings seal bearing drill guide

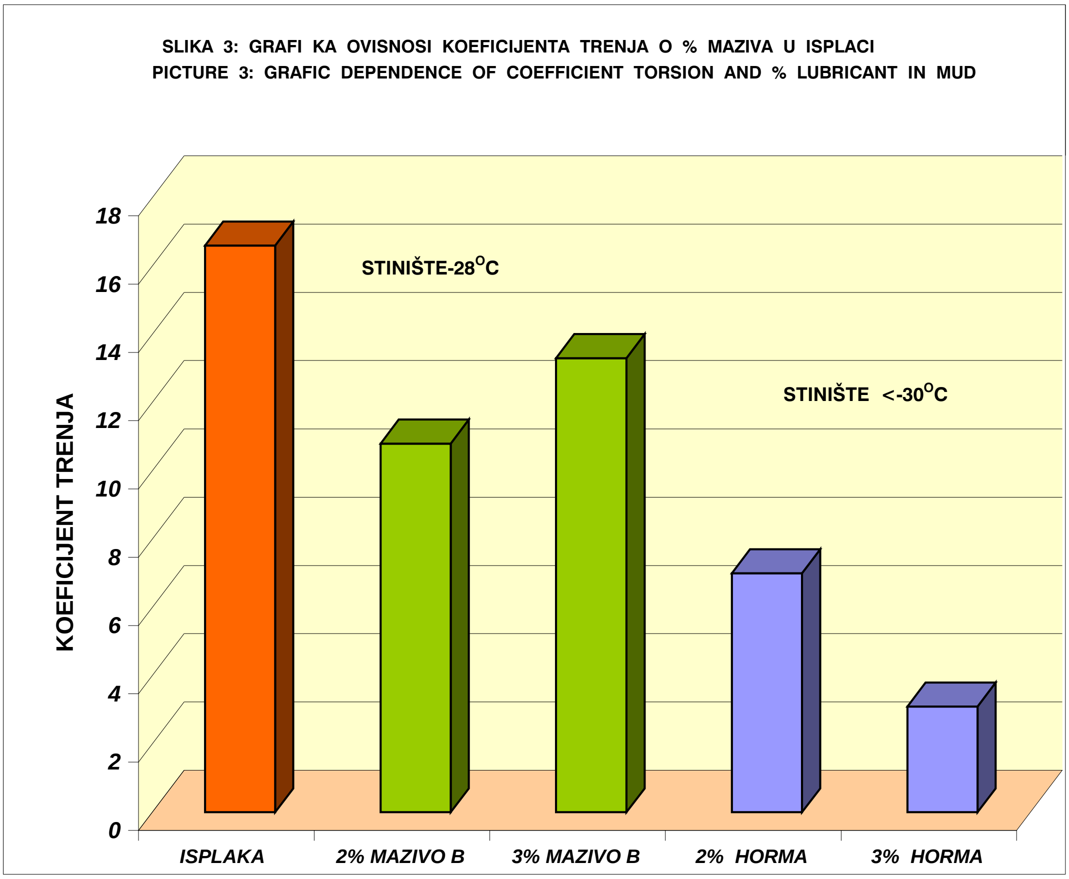
Slika 2: Grafički prikaz ovisnosti koeficijenta trenja o postotku maziva u isplaci
Figure 2: Graphical outline of the friction coefficient dependence on lubricant percentage in the mud



friction coeficient drilling mud lubricant

Slika 3: Grafička ovisnost koeficijenta trenja o postotku naziva u isplaci

Figure 3: Graphical outline of the friction coefficient dependence on lubricant percentage in the mud



pour point friction coeficient drilling mud lubricant

DEVELOPMENT OF RAPESEED OIL - BASED LUBRICANT FORMULATION FOR HORIZONTAL WELLS

Abstract

Lubricant for horizontal wells shall be applied in mud for increasing their lubricating properties during the performance of drilling procedures. A good lubricating property of drilling mud is very important for a considerable time-saving, prolongation of equipment durability, reduction of the number of manoeuvres, and more cost-effective operation of the entire drilling procedure.

Pollution of the environment (soil and water) is preventable by applying environmentally more advatageous raw materials in lubricants. Rapeseed oils belongs to a group of base oils acceptable for the environment, so, in addition to an easy and relatively fast biodegradation it has also other advantageous properties as good lubricity, high viscosity, good adhesiveness to metal surfaces, and very good loadcarrying properties. It is possible to improve poor application properties of rapeseed oil: behaviour at high and low temperatures, hidrolytic stability, as well as foaming property, by admixing suitable additives.

INTRODUCTION

In horizontal drilling (Figure 1), due to larger curvature of a part of the wellbore, there is an increased friction of the drilling equipment against the wellbore walls compared to vertical or only mildly curved wells. Drilling mud is a medium intended for well washing out during its construction i.e. drilling operation. Muds are added additives intended for improving its properties, such as: surface-active substances, emulsifiers, lubricants, corrosion inhibitors, sealing compounds, etc. Increasing drilling depths, temperatures, and pressures, but also increasingly complex and precise drilling equipment, require improved mud properties, so that mud additives represent an area of continuous research and development work, including, among other, also chemical specialists. Friction reduction may be achieved by selecting and applying muds with good lubrication properties. In order to achieve such lubrication properties, additives for horizontal well lubricants have been and are furtherly being developed and researched. Figure 2 shows different lubrication effects of commercial lubricants A, B, and C in the mud, as opposed to mud lubrication without additives.

LUBRICANTS BASED ON RENEWABLE SOURCES

Greases and oils of animal origin constitute the oldest sources, and have a long application history as bases for different lubricants. However, due mostly to their limited temperature stability, their application is also limited. Through the development of oil processing in the first half of the 20th c., due to increasingly demanding and diversified application, they have gradually been replaced by mineral oil-based lubricants. It is well-known that a part of the application i.e. of the market is today covered also by synthetic oil-based lubricants.

Awarenes is recently becoming raised of the harmful human health and environmental effects of polycyclic aromatic compounds (PCA) and sulphur present in mineral oils. According to some sources, sulphur pollutes the environment more than CO_2 generated through combustion (greenhouse effect). Renewable source-based lubricants i.e. greases and oils are mostly categorized as specialty lubricants. With environmental and human health awareness raising, greases and oils, as renewable sources, are becoming more and more topical. They are paid more attention and the possibility of their substituting mineral oils on a large scale is being investigated, resulting in the change of overall lubricants composition. Natural greases and oils almost do not contain any sulphur, they are biodegradable - unlike mineral and synthetic oils, and they are also known for their good lubrication properties. We should stress, however, that a complete return to an exclusive use of renewable sources - in this case, greases and oils - is not possible.

ADDITIVES IN LUBRICANTS FOR HORIZONTAL WELLS

Lubricants which are animal- or vegetable-, fossil- or synthetic- based are added various additives, preventing the lubricant -owing to their good lubrication properties - from impairing the mud's physico-chemical or rheological properties. This is, after all, the very reason for their adding. That is why the composition of mud lubricants is very complex. When a lubricant, which is a mostly organic component, is added into water muds, which themselves have a highly diversified composition, it is impossible to avoid emulsifiers, dispersants, antifoaming agents, and - due to low temperature storing conditions - most frequently also pour point depressants.

EXPERIMENTAL WORK

The purpose of the research was to formulate the composition of additives for horizontal wells to be used in muds, the share being 2 and 3 mas.% respectively, same as in the case of commercial lubricant B. It also has to have the same or even better efficiency than the commercial lubricant B, without at the same time impairing the mud's physico-chemical or rheological properties. Our own lubricant formulation HORMA was ca. 95% made of domestic feeds. The composition of HORMA is both environmentally tolerable and toxicologically acceptable. The preparation procedure is simple and requires no special equipment (stirrer, heating up to 60^{0}C). The horizontal well lubricant includes: refinery processing derivative, rapeseed oil, emulsifier, antifoaming agent, and pour point depressant synthesized at INA.

DISCUSSION OF RESULTS

Commercial lubricant inversion established through testing i.e. improved lubrication in lower volumes (2 mas% better than 3 mas%) is of no particular consequence for application. The lubricant is added to muds in the amount of 2 mas%, and this is more or less maintained during well completion and operation, while the lubricating efficiency itself is to be expected somewhere in the range of 2-3 mas%.

What indicates lubricating efficiency in actual application is the torque at drilling parameter i.e. the lubricant friction coefficient. The lower the coefficient, the better the lubrication properties. Figure 3 and Table 1 show that HORMA lubricant formulation has lower friction coefficient values (depending on the amount of lubricant added to the mud: 2 or 3%) than the commercial lubricant B. HORMA lubricant has lower pour point temperature in comparison with the commercial lubricant B, which means that it can be both stored and applied at lower temperatures (-30^{0}C min.) (Figure 3).

CONCLUSION

Comparative testing of commercial lubricant B and HORMA lubricant, developed at INA-SSRI, has shown that HORMA, when incorporated into the drilling mud, almost does not change the mud's physico-chemical and rheological properties at all. This is a condition necessary for well operation, since their major changes (Table 1) would lead to operational problems. Lubrication and pour point of HORMA show a definite advantage with respect to commercial lubricant B.

Literatura / References:

1. MARTINKO B., *Uloga isplake pri izradi dubokih bušotina*, INA Naftaplin OOUR bušenje, Zagreb 1983.
2. MORTIER R.M., ORSZULIK S.T., *Chemistry and Technology of Lubricants*, Blackie Academic & Professional, London 1992.
3. *Maziva i podmazivanje*, Jugoma, Zagreb 1986.
4. ODIAN G., *Princeples of polimerization*, McGraw- Hill Book Company, New York 1970.
5. RICHARD BOOSER E., *Handbook of lubrication*, CRC Press, Inc. Boca Roton, Florida 1984.
6. ROSEN M.J., GOLDSMITH H.A., *Systematic Analysis of Surface Active Agent*, John and Johns Inc. New York 1972.
7. MILWIDENSKY B.M., GABRIEL D.M., *Detergent Analysis - A Handbook for Cost effective Quality Control*, London 1981.
8. BISHT R.P.S., BHATIA V.H., *Synthetic Lubricants*, 14, 23. 1997.
9. BALESHN M., HERDAN J.H., *Synthetic Lubricants*, 14, 25. 1997.
10. MILES P., *Lubrication Engineering*, 53, 43, 1997.
11. BRNIĆ Z., *Priručnik o isplaci*, INA Naftaplin OOUR bušenje, Zagreb 1989.
12. ESCARD A. i dr., *Lubrication Engineering*, 53, 17, 1997.
13. SARIN R. i dr., *Lubrication Engineering*, 53, 21, 1997.

ključne riječi:	key words:
622.243.24 horizontalne bušotine	horizontal wells
622.24.063 aditivi za isplaku bušotina	drilling mud additives
665.334.94 repičino ulje	rapeseed oil
576.343 biorazgradljivost	biodegradability

Autori/Authors:
Ljiljana Marinić Pajc, Jasenka Petran, INA-SSRI Zagreb

Primljeno/Received:
10.07.1999.