8th International Tribology Conference
Osma internacionalna konferencija o tribologiji
Beograd, 8. - 10. oktobra 2003.

PACKAGE TYPE ADDITIVES FORMULATION AND SYNERGETIC EFFECTS

N. N. ANTONESCU, F. FLOREA and **L. ANTONESCU**
Mechanical and Electrical Engineering Faculty, Petroleum-Gas University, Ploiesti, Romania

Summary

Synergetic effects are very important for "package" type additives formulation. The paper present the results obtained on the four-ball machine with chemical active type additives at high concentrations and influence of friction modifier additive on the wear reduction.

A number of lubricating compositions are tested at turning and drilling.

Keywords: *synergetic effects; package additive; turning; drilling*

1. INTRODUCTION

Lubricant formulation for different domain of application, require to including moreover additives in base oil. Different additives combination has the synergetic effects – the increase of additives efficiency – or contrary effects. Synergetic effects depend of relative additives concentration, chemical elements, load, temperature, materials etc. These made on four-ball machine to obtain one additive package with the best antiwear and EP results.

The fluid obtained with this package is tested at turning and drilling.

2. TEST CONDITIONS

In this paper, are utilized additives with chemical active elements (clorine, sulphur, phosphorous) and one pollar combination, so called "friction modifier" additive.

The additives quotation and concentration of chemical elements are presented in table 1.

The additives and selected "package" was dispersed in a mineral oil type ISO VG 32 with principal characteristics:

- *Viscosity at 40^0C, mm^2/s (cSt) 30.2*
- *Viscosity index …………………… 95*
- *Pour point, ^{0}C …………………… - 12*

On the four-ball machine are made the tests for following parameters:

- *Weld load, "W_L"→1450 rot/min, 1 minute*
- *Wear scar diameter*:
  "D" → 1500 N, 1 minute
  „d" → 400 N, 60 minutes

Table 1.

Additive Type	Chemical element	
	Name	Content, % wt
ACl	Clorine	42.1
AS	Sulphur	10.05
AP	Phosphorous	9.01
FM	Friction modifier (oxidized vegetable oil)	

Turning tests:
* Workpiece material: medium carbon steel; 0.488%C, 0.735%Mn, 0.0245%S, 0.0281%P
* Tool: cemented carbide P 30 (commercial grade)
* Feed rate: 0.05…0.18 mm/rot
* Depth of cut: 1.2 mm

Drilling tests:
* Workpiece material: medium carbon steel; 0.488%C, 0.735%Mn, 0.0245%S, 0.0281%P

* Tool: standard drill (Rp 5), D = 20 mm
* Speed: 500 rot/min
* Feed rate: 0.11; 0.16; 0.22 mm/rot

3. EXPERIMENTAL RESULTS AND DISSCUTIONS

3.1 Four-ball tests

Results obtained with different chemical additives concentration and friction modifier component are presented in the tables 2… 4.

Based on these results, the following can be draw:

* When SA additive concentration, in sample with ClA+FM increase (table 2), weld load (W_L) increase and wear, at high load and short time (D) and at low load and long time (d), decrease.
* The increase concentration of FM from 10% wt. to 15% wt. (for 1.5% wt. S) are no influence for weld load.
* With increasing in ClA additive contents (table 3) weld load increase. The influence of FM additive is practically the same for all concentrations (5…15% wt.). At high forces, the presence of friction modifier (FM) in concentration after 5% wt. is not positive influence.
* For 10…15% wt. FM content in ClA, when SA concentration increase from 1% wt. to 1.5% wt. S, the wear ("d" parameter) increase. This fact is possible supposing the chemical wear appearance because of the high temperature generated by friction.
* Based on the all aspects presented, the best results are obtained with the combination: ClA+1.5% wt. S+10% wt. FM.

The results obtained with this combination and phosphorous additive (PA) are presented in the table 4.

* When PA additive content increase, the weld load rise and wear decrease. For "d" parameter, after 0.75% wt. P content, the wear rise. In this case, the additive combinations have contrary effects of those synergetic.
* For all combinations, in presence of FM obtain the increase of weld load and wear, but this influence is very small. The efficiency of FM additive increase at reduced concentration of additives with chemical active elements (ClA, SA, PA).

3.2 Turning and drilling tests

Turning and drilling tests were performed with two lubricant samples:

A. 10% wt. Cl+10% wt. FM+1.5% wt. S+ 0.75% wt. P+ mineral oil (ISO VG 32) for 100%.;

B. 50% concentrate A + 50% mineral oil.

Turning

To determine the cutting life, the average wear on the flank face of the tool are established at 0.3 mm (ISO 3685).

The cutting life of the tool variation with speed and feed rate are presented in figure 1.

Based on results presented in this figure, can be draw:

* The maximum values of the cutting life are obtained for 0.08…0.12 mm/rot feed rate and 100 m/min cutting speed.
* At reduced values of speed and feed rate, sample A (package additives) have high efficiency. In these conditions, the lubricating properties are great importance.
* For all feed rate values utilized and cutting speed above 100 m/min, cutting life is higher, because the cooling process and penetrating ability between friction surfaces become important.

Drilling

The basically face wear value of 0.3 mm was the criterion for ending the test. Two values of depth of drilling (H_1= 20 mm, H_2= 50 mm) and 2.5 l/min lubricant flow rate are utilized.

The results obtained are presented in figure 2 and based on this, the following remarks can be made:

* The durability of the drills (number of holes) is influenced, for the same material and speed, by lubricant and depth of drilling.
* At high depth of drilling values, durability obtained with sample B is higher. This is possible because the cooling and the penetrating ability of fluid is more higher, and EP characteristics are a little influence.

REFERENCES

[1] Nabil, Al-H., Antonescu, N.N., Florea, F., Synergetic effects at high additive concentrations, 7-th Conference on EHD Lubrication and Traction, 2-4 Jun., 1994, Suceava University, p. 77-91

[2] Neacsu, M., Cutting life of uncoated and coated cemented carbide cutting tools, Balkantrib '99, The 3rd. International Conference of Tribology, 2-4 Jun., 199, Sinaia, Romania, vol.1, p.219-224

Table 2.

Parameter	S, % wt.	Cl, % wt.					FM, % wt.	Efficiency, %	
		2	4	6	8	10		AS	FM
W_L, N	0.5	4200	5150	5500	5900	6000	5	100	100
	1.0	4750	5500	6000	6400	6800	5	110	100
	1.5	5500	6300	6900	7500	7950	5	127.7	100
	0.5	4200	5100	5500	6000	6100	10	100	100.6
	1.0	4800	5600	6100	6500	6700	10	110.4	100.8
	1.5	5600	6400	7000	7500	8000	10	128.2	101
	0.5	4100	5000	5400	5800	5900	15	100	98
	1.0	4600	5500	6000	6300	6500	15	110.3	98.1
	1.5	5400	6200	6800	7400	7800	15	128.2	98.4
D, mm	0.5	1.61	1.2	1.03	0.93	0.89	5	100	100
	1.0	1.42	1.07	0.95	0.88	0.86	5	108.5	100
	1.5	1.29	1.00	0.89	0.81	0.8	5	115.4	100
	0.5	1.57	1.15	0.98	0.90	0.84	10	100	103.9
	1.0	1.37	1.05	0.95	0.85	0.85	10	106.8	102.1
	1.5	1.25	0.95	0.86	0.80	0.77	10	114.9	103.3
	0.5	1.54	1.11	0.99	0.93	0.91	15	100	103.2
	1.0	1.34	1.05	0.93	0.84	0.81	15	109.3	104
	1.5	1.28	1.00	0.87	0.80	0.77	15	113.9	101.5
d, mm	0.5	1.10	0.93	0.86	0.80	0.75	5	100	100
	1.0	0.98	0.85	0.75	0.70	0.66	5	111.3	100
	1.5	0.86	0.75	0.70	0.66	0.63	5	118.9	100
	0.5	0.97	0.85	0.75	0.74	0.70	10	100	109.7
	1.0	0.90	0.75	0.69	0.63	0.60	10	111	109.4
	1.5	0.80	0.70	0.64	0.60	0.58	10	117.2	107.8
	0.5	1.05	0.90	0.80	0.79	0.75	15	100	103.4
	1.0	0.90	0.80	0.63	0.7	0.63	15	114.7	107.1
	1.5	0.80	0.73	0.66	0.60	0.60	15	121	105.8

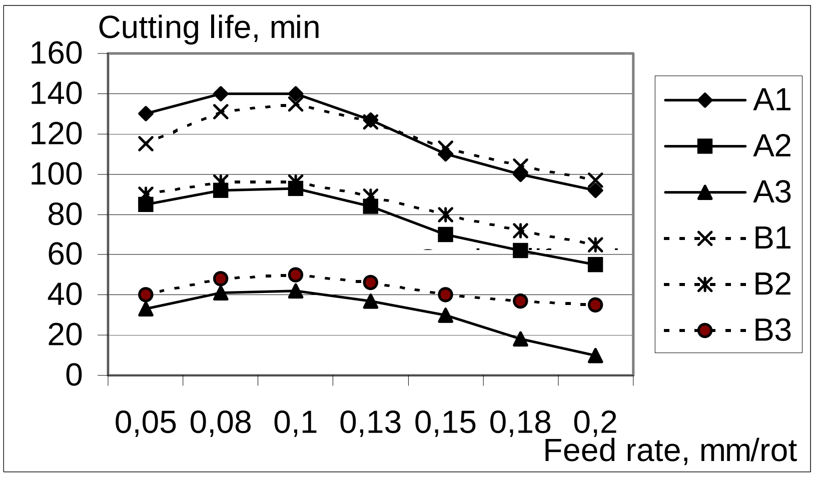

Fig.1. Cutting life evolution at turning:
A – sample A; B – sample B; 1 → 100 m/min; 2 → 150 m/min; 3 → 200 m/min

Table 3

Parameter	Cl, % wt.	S, %wt.			FM, %wt.	Efficiency, %	
		0.5	1.0	1.5		ClA	FM
W_L, N	2	4200	4750	5500	5	100	100
	4	5150	5500	6300	5	117.3	100
	6	5500	6000	6900	5	127.3	100
	8	5900	6400	7500	5	137	100
	10	6000	6800	7950	5	143.6	100
	2	4200	4800	5600	10	100	101
	4	5100	5600	6400	10	117.1	100.9
	6	5500	6100	7000	10	127.4	101.1
	8	6000	6500	7500	10	137	101
	10	6100	6700	8000	10	142.5	100.2
	2	4100	4800	5600	15	100	100.3
	4	5000	5600	6400	15	117.2	100.3
	6	5450	6000	6900	15	126.5	99.7
	8	5900	6400	7500	15	136.5	100
	10	6000	6700	7900	15	142	99.3
D, mm	2	1.61	1.42	1.29	5	100	100
	4	1.20	1.07	1.00	5	124.3	100
	6	1.03	0.95	0.89	5	133.6	100
	8	0.93	0.88	0.81	5	139.3	100
	10	0.89	0.86	0.80	5	141	100
	2	1.57	1.37	1.25	10	100	103
	4	1.15	1.05	0.95	10	124.8	103.7
	6	0.98	0.95	0.86	10	133.4	102.8
	8	0.90	0.85	0.80	10	139.1	102.7
	10	0.84	0.85	0.77	10	141.3	103.5
	2	1.54	1.34	1.28	15	100	103.7
	4	1.11	1.05	1.00	15	124	103.4
	6	0.99	0.93	0.87	15	132.9	102.8
	8	0.93	0.84	0.80	15	138.2	101.9
	10	0.91	0.81	0.77	15	140.1	102.3
d, mm	2	1.1	0.98	0.86	5	100	100
	4	0.93	0.85	0.75	5	113.9	100
	6	0.86	0.75	0.70	5	121.4	100
	8	0.80	0.70	0.66	5	126.5	100
	10	0.75	0.66	0.63	5	130.6	100
	2	0.97	0.90	0.80	10	100	109.2
	4	0.85	0.75	0.70	10	113.9	109.1
	6	0.75	0.69	0.64	10	122.1	110
	8	0.74	0.63	0.60	10	126.2	108.8
	10	0.70	0.60	0.58	10	129.6	107.8
	2	1.05	0.90	0.80	15	100	106.5
	4	0.90	0.80	0.73	15	111.6	103.9
	6	0.80	0.63	0.66	15	124	109.5
	8	0.79	0.70	0.60	15	124	103.2
	10	0.75	0.63	0.60	15	128	102.9

Table 4. *Weld load and wear parameters variation with phosphorous content for sample with 10% wt. FM and 1.5% wt. S*

Parameter	P, %	Cl, %					Efficiency, %
		2	4	6	8	10	
W_L, N	0	5600	6400	7000	7500	8000	100
	0.1	5400	6250	6750	7000	7150	64.4
	0.25	5500	6400	6850	7250	7500	97.1
	0.50	5600	6700	7000	7500	8000	100.9
	0.75	5700	6800	7150	7700	8200	103
	1.0	5700	7000	7250	7800	8300	104.5
D, mm	0	1.25	0.95	1.86	0.80	0.77	100
	0.1	1.30	1.00	0.90	0.80	0.80	96.3
	0.25	1.26	0.90	0.85	0.80	0.80	100.4
	0.50	1.10	0.85	0.80	0.77	0.74	108
	0.75	1.00	0.77	0.73	0.70	0.68	116.2
	1.0	0.90	0.73	0.70	0.65	0.65	121
d, mm	0	0.80	0.70	0.64	0.60	0.58	100
	0.1	0.85	0.73	0.64	0.60	0.60	97
	0.25	0.80	0.70	0.62	0.60	0.58	100.6
	0.50	0.67	0.61	0.60	0.57	0.60	108.1
	0.75	0.62	0.58	0.55	0.53	0.62	112.6
	1.0	0.65	0.60	0.56	0.53	0.60	111.4

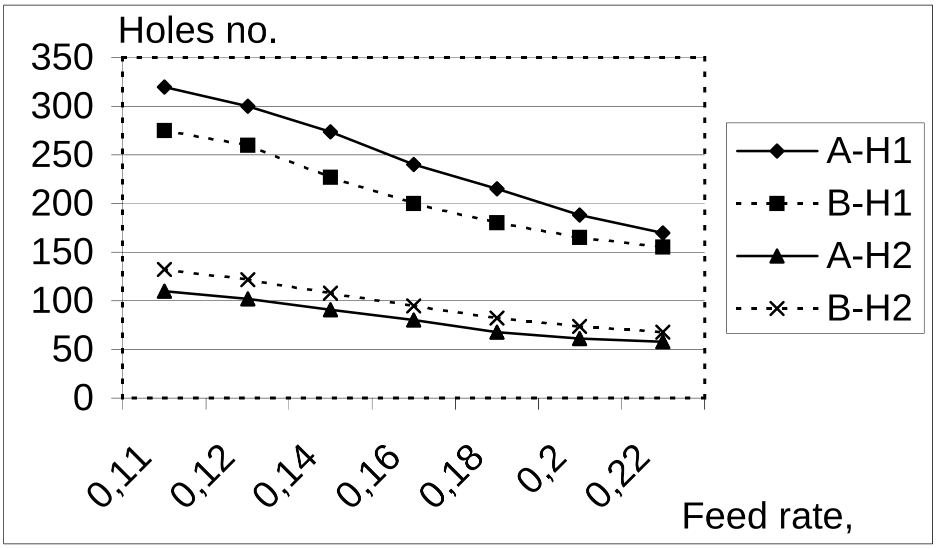

Fig.2. Drills durability: A – sample A; B – sample B; H1 = 20 mm; H2 = 50 mm