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Deep Stamping Lubricant for Heavy Duty Conditions

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Abstract

In the automotive industry, especially for cars, most of the component parts are manufactured by casting welding and cutting-working. There are, also, component parts which can only be made by deep stamping, such as: fuel tanks, oil baths, bumper etc. The present study is referring to the elaboration of deep stamping lubricants, used in automotive industry as an alternative for similar products made of paste. In laboratory, it was realized products whose performance meets the high standards and the latest international trends (in this domain). These products have the following characteristics: extreme pressure resistance, copper corrosion prevention, good adhesion at the metallic surface, easy removing by washing. The products have been tested in real working conditions and proved that they make possible the stamping of the steel – sheets characterised by 3-4 mm thickness, instead of the paste – lubricants used for the deep stamping of the steel-sheets characterised by 1.2-1.5 mm .

Key words: *deep stamping lubricants, steel-sheets casting*.

Introduction

In the automotive industry, especially for cars, most of the component parts are manufactured by casting welding and cutting-working. There are, also, component parts which can only be made by deep stamping, such as: fuel tanks, oil baths, bumper etc.

Deep stamping process presume high casting pressure, large range values of steel sheet thickness and various shape and depth of the profile.

For a successful casting of the steel-sheet, it is necessary to use special lubricants that are laid on the dies for ensuring the prevention of seizure or breaking of the steel-sheet as well as a smooth and uniform aspect of the profile surface.

Usually the lubricants used for stamping are paste type lubricant, based on sodium soap; these lubricants can be used under maximum casting pressure of 30 daN, for maximum steel sheet thickness of 1.2-1.5 mm. They are difficult to be spread on the steel sheet and difficult to be removed by washing with water from the metallic surfaces.

Theoretical Aspects

The new tendency in deep stamping is the use of oils lubricants with antiseizure properties, extreme pressure resistance, anticorrosion properties and easy removing from the metallic surfaces by washing with water. The specific characteristics and performance requirements imposed to the deep stamping lubricants are presented in table 1 [5].

Table 1. Physical, chemical and performance characteristics

Physical, chemical and performance characteristics	Requirements of cars manufacturer	ASTM methods
Density at 20 ^{0}C, max .	0.925	D 941
Viscosity at 40 ^{0}C, cSt, min.	350	D 445
Flash point, ^{0}C, min.	230	D 92
Pour point,^{0}C, max.	-10	D 97
Copper corrosion (3h, 100 ^{0}C) max.	2	D 130
4 Ball test- weld load, daN, min.	500	D 2783

Experimental Study and Results

The present study is referring to the elaboration of liquid type of deep stamping lubricants that accomplish all the requirements of the car manufacturers and provide high pressure resistance and superior washability.

In order to accomplish the above mentioned requirements, deep stamping oils are made of high viscosity mineral base oils [2], anti-seizure additives, corrosion inhibitors, extreme pressure additive, detergent-dispersant and washing additives.

The high pressure resistance are ensured by a sulfurised iso-buthene additive type that forms a resistant film on the steel sheet surface, by chemosorbtion process [3]. In this way the formed film takes efficiently the pressure stress and protects the metallic surface.

Formulation of Deep Stamping Lubricants

For the formulation of deep stamping oils, many types of base oils and different additives for each functional category were tested.

An important goal was to realize the synergism between the specific additives used for the oil formulation to obtain the imposed values of characteristics, at minim quantity of additives.

The study consists in the characterisation of the selected base oils and additives, as well as the testing results that are presented further.

The evaluation of the characteristics was in accordance with specific ASTM testing methods [4].

Base oil

Base oil is a mineral oil that it is necessary to have a high a viscosity, frequently in the range of viscosity class ISO-VG 320 and ISO-VG 460. Table 2 presents physical and chemical characteristics of selected base oil type.

Table 2. Physical and chemical characteristics of base oil

Physical and chemical characteristics	Values	ASTM methods
Density at 20 ^{0}C	0.922	D 941
Viscosity at 400 ^{0}C, cSt	466	D 445
Flash point, ^{0}C	245	D 92
Pour point, ^{0}C	-6	D 97

Additives

The additives are very important in ensuring different functions of lubricant oils; these specific functions couldn't be provided by the base oils as such.

Selected additives types, used in this study of deep stamping oil formulation, are:

- **Extreme pressure additive** with the following characteristics:

Density at 20^0C	1.05 -1.1
Decomposition temperature, ^{0}C	150
Viscosity at 20^0C , cSt	400 - 500
Sulphur ,% wt, min	36
Flash point, ^{0}C	120

- **Detergent-dispersant additive** is a natural sodium sulfonate with antirust, anticorrosion, detergent-dispersant and washing properties.
- **Depressant additive** is a polymethacrilate soluble in mineral oil and compatible with another additives used in lubricants formulations.

The above mentioned components were used for the new deep stamping oil formulation. The optimum formula has the following dosage of components:

- Extreme pressure additive, % wt 4
- Detergent-dispersant additive, % wt 3
- Depressant additive% wt 0.5
- Base oil, %wt <100

The deep stamping oil formulated in conformity with the specific additives and dosages presented above, was characterized according with the testing methodology and requirements agreed by the cars manufacturers, at international levels. In the table no.3 are presented the average values obtained for specific characteristics of the formulated deep stamping oil.

Table 3. Characteristics of formulated deep stamping oil according to international requirements

Physical, chemical and performance characteristics	International requirements	Obtained value	ASTM methods
Density at 20 ^{0}C,max .	0.925	0.921	D 941
Viscosity at 40 ^{0}C, cSt, min.	350	458	D 445
Flash point, ^{0}C,min.	230	241	D 92
Pour point, ^{0}C, max.	-10	-20	D 97
Copper corrosion (3h, 100 ^{0}C), max.	2	2b	D 130
Four Ball test- weld load, daN, min.	500	500	D 2783

Evaluating the testing results obtained for the deep stamping oil formulated at laboratory level, could be observed that the characteristics are correlated with the requirements agreed for this type of lubricant at international level.

Experimentation of Deep Stamping Lubricants in Real Working Conditions

An edifying proof of the lubricants capability is the testing of these in real working conditions [1]. This assessment could confirm or not the sustainability of the lubricant concept formulation.

Starting from the laboratory test results, two types of deep stamping oils were formulated for the purpose of experimentation in real working conditions. Encoding of these oils is: UA1 and UA2.

The UA1 oil was realized in conformity with the before established formula.

Formulation of experimental oil UA2 take in consideration the possibility of an extreme pressure surcharge necessity in real working conditions and the supplementary requirement of washing capacity (asked by the cars manufacturers). Therefore, in the formulation of experimental oil UA2, the extreme pressure additive was supplemented to 5% wt and 1% wt washing additive was added.

So, the experimental deep stamping oils were differentiated by extreme pressure performance level and washing capacity on the metallic surfaces.

The characteristics of the UA1 and UA2 deep stamping lubricants are presented in table 4.

Table 4. UA1 and UA2 deep stamping oil characteristics

Physical, chemical and performance characteristics	UA1	UA2	ASTM methods
Density at 20^0C.	0,921	0,925	D 941
Viscosity at 40^0C, cSt.	458	460	D 445
Flash point, ^{0}C.	241	231	D 92
Pour point,^{0}C.	-20	-10	D 97
Copper corrosion (3h,100^0C)	2b	2b	D 130
4 Ball test- weld load, daN.	500	580	D 2783
Washability	-	pass	visual

UA1 and UA2 lubricants were tested, also, in DACIA Groupe RENAULT laboratories. After this preliminary verification, the experiments continued on the factory stands, where they were testing accordingly with the cars manufacturer methodology.

The deep stamping oils UA1 and UA2 have to pass the stress test on steel-sheets of 1; 2; 3; 4; 5 mm thickness.

The experimental oils were laid over the steel sheet to form a uniform lubricant film, using a smooth brush.

The steel - sheet was casted on different shapes and profiles of the testing stand. The loaded pressure was correlated with the thickness of steel sheet and the profile (shape and depth) of the testing stand.

The testing methodology includes 5 sequences differentiated by steel sheet thickness, level of loading pressure, shape and depth of the casting profile.

The parameters of testing methodology on the stand, as well as, experimental testing results obtained for both oils are presented in the tables no.5 and 6.

The results and the observations collected during the experimental tests on cars manufacturer stands show the following aspects:

- the two experimental oils have a quite different behaviour for superior thickness values and high pressure range;
- lubricant UA1 passed the test until sequence 3 of the experiment (steel-sheet thickness 3 mm, pressure loading 40 daN);
- lubricant UA2 passed the test until sequence 4 of the experiment (steel-sheet thickness 4 mm, pressure loading 40 daN);

- these lubricants could be used in proper conditions, ensuring a good casting behaviour until sequence 3-for UA1 and until sequence 4- forUA2;
- the both lubricants were easy removed from the dies surfaces, especially UA2 that is very easy removed by washing with water.

Table 5. UA1 deep stamping oil behaviour in real working conditions

Steel-sheets thickness, mm	Loading pressure, daN	Maximum depth of profile, mm	Aspect of the casting sheet	Noise occurred during the test	Test evaluation
1	30	20	Smooth and uniform	No noise	pass
2	30	30		No noise	pass
3	40	50		indefinite noise	pass
4	40	50	Indefinite stress traces	low noise	failed
5	50	70	Visible traces of breaking	Specific breaking noise	failed

Table 6. UA2 deep stamping oil behaviour in real working conditions

Steel-sheets thickness, mm	Pressure loading, daN	Maximum depth of profile, mm	Aspect of the casting sheet	Noise occurred during the test	Test evaluation
1	30	20	Smooth and uniform	No noise	pass
2	30	30		No noise	pass
3	40	50		No noise	pass
4	40	50		indefinite noise	pass
5	50	70	Fine traces of stress	low noise	failed

Both experimental oils have a good behaviour corresponding to the cars manufacturer requirements.

Conclusions

- Deep stamping lubricants products formulated by the selected additives and base oil are in accordance with international cars manufacturers requirements.
- Two experimental deep stamping oils were realized, UA1 and UA2. They were differentiated by extreme pressure performance level and washing capacity on the metallic surfaces;
- The experimental oils were tested in real working conditions, gradually on the steel-sheets of 1; 2; 3; 4; 5 mm thickness.
- According with the experimental results obtained on the testing stands, these lubricants could be used in proper conditions, ensuring a good casting behaviour until sequence 3-for UA1 and until sequence 4- forUA2;
- UA1 and UA2 deep stamping oils have higher performances than traditionally paste-lubricant type. These new lubricants provide extreme pressure resistance and washability, as well as decrease copper corrosion.

References

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Lubrifianţi pentru matriţare în condiţii severe

Rezumat

În industria constructoare de maşini, în special în cea pentru automobile, majoritatea componentelor se confecţionează prin presare în matriţe şi prin procese de tăiere. De asemenea, sunt anumite părţi de componente care se realizează numai prin presare adâncă, cum ar fi: rezervoarele de combustibil ,rezervoare de ulei şi bare de protecţie. Prezentul studiu se refera la elaborarea unor uleiuri lubrifiante utilizate in industria constructoare de automobile pentru prelucrare prin matriţare la rece, ca alternativă a lubrifianţilor de tip pastă utilizaţi în mod uzual. Au fost realizate în laborator produse de acest tip care au îndeplinit cerinţele de calitate agreate la nivel internaţional, precum şi noi cerinţe apărute ca solicitare a anumitor constructori de maşini. Produsele realizate îndeplinesc următoarele condiţii: rezistenţă la presiune ridicată, prevenirea coroziunii, buna aderenţă la suprafaţa metalică, precum şi îndepărtarea uşoară de pe suprafaţa care a fost profilată. Produsele au fost testate şi din punct de vedere al funcţionării în condiţii reale de exploatare, demonstrând că pot fi utilizate pentru matriţarea foilor de oţel cu grosimi de până la 3-4 mm, în timp ce lubrifianţii de tip pastă folosiţi uzual, pot fi utilizaţi numai pentru grosimi ale foilor de oţel de 1,2 – 1,5mm.