

Deliverables

ARISEN

Innovation in Lubrication for Sustainable Manufacturing

Participants:

BELGIN OIL
TOOPRESSE
CENTIMFE



SMART Office

Date: 08.31.2022

D1.1 Determination of technical specifications of the product

- BELGİN Product Technical Specification:

It was decided to apply the following tests primarily to the formulations created during the product development studies.

Table 2: Product Technical Specification.

Property, metric and test	Test Method	Target Value
Kinematic Viscosity (40°C, cSt)	ASTM D 445	10-500
Pour Point (°C)	ASTM D 97	max -10
Flash Point (°C)	ASTM D 92	min 140
Total Acid Number (TAN) (mg KOH/g)	ASTM D 974	max 5,0
Foam Test (mL/mL, Sq I)	ASTM D 892	max 50/0
SRV Friction Test (fmax) (for Al/Ti)	ASTM D 6425	max 0,500
SRV EP Step Test (N) (for Al/Ti)	ASTM D 5706	min 400
Tapping Torque Test for Al/Ti (Nm)	BLN 105	max 350
Rust Test	ASTM D 665 A	Pass
Aluminum Staining Test	BLN 99	Pass
Wettability Test	BLN 172	Good
Cleanability Test	BLN 147	Must be easy
Biodegradation Test	OECD 301	min %80

D1.2 Determination of Industrial Trial Specifications

- Centimfe-Toolpresse Industrial Trial Technical Specification:

The operational test technical specification criteria that a biodegradable lubricant suitable for the MQL system should have for the processing of titanium and aluminum alloys, which will be the industrial trial output determined by Centimfe-Toolpresse.

1) Suitable for turning and milling metalworking process.

2) Suitable for external MQL system.

3) Compatibility with the following materials.

- In the turning of the aluminum specimens will be used polished hard metal inserts. And for titanium specimens will be used TiAlN coated hard metal inserts.
- In the milling of aluminum specimens, will used integral hard metal cutting tools and for the titanium specimens will used hard metal tools coated with TiAlN .

- In the milling of aluminum and titanium specimens will used integral hard metal cutting tools with 10mm diameter, 4 flutes and 2.5mm corner radius.
- In the turning of aluminum and titanium specimens will used hard metal inserts with 55° and 0.2mm corner radius.

4) Should provide performance within the selected cutting parameters range for the turning and milling tests performed with aluminum and titanium as specified below.

- Cutting speed (V_c) in two levels.
- The feed per revolution (f_n) in two levels.
- The depth of cut (a_p) in two levels.
- MQL spraying in two levels.

5) Should be workable within the following machining conditions.

- Turning of aluminum V_c : 250 - 400m/min; f_n : 0.07mm - 0.15mm/rev.; a_p : 0.2 - 0.3mm and MQL: 40 - 80 ml/h.
- Turning of titanium V_c : 50 - 80m/min; f_n : 0.05mm - 0.10mm/rev.; a_p : 0.05 - 0.2mm and MQL: 60 - 150 ml/h.
- Milling of aluminum V_c : 250 - 400m/min; f_z : 0.06mm - 0.12mm/rev.; a_p : 0.05 - 0.10mm and MQL: 40 - 80 ml/h.
- Milling of titanium V_c : 50 - 80m/min; f_z : 0.05mm - 0.10mm/rev.; a_p : 0.05 - 0.10mm and MQL: 60 - 150 ml/h.

In short;

Turning and milling operations will be applied.

- Aluminum turning: polished carbide inserts, titanium turning: TiAlN coated carbide inserts
- Aluminum milling: integrated carbide cutting tools, titanium milling: TiAlN coated carbide tools
- Milling of aluminum and titanium: Integrated carbide cutting tools with a diameter of 10 mm, 4 flutes and a corner radius of 2.5 mm,
- Aluminum and titanium turning: 55° and 0.2mm corner radius carbide inserts,
- External MQL system will be used.

Trials will be carried out under the following operating conditions.

Technical Specifications	Aluminum turning	Titanium turning	Aluminum milling	Titanium milling
Two levels of cutting speed (Vc) (m/min)	250- 400	50-80	250-400	50-80
feed per revolution (fn) in two levels (fn) (mm/rev)	0.07- 0.15	0.05-0.1	0.06-0.12	0.05-0.1
Two levels of (axial) depth of cut (ap) (mm)	0.2- 0.3	0.05-0.2	0.05-0.1	0.05-0.1
MQL spray amount in two levels (ml/h)	40- 80	60-150	40-80	60-150

D2.1/ D2.2 Determination of Product Formulation/ Determination of Test Results

- For this task; The formulations created in the previous task, which were thought to lead to the final product, were tested in accordance with the technical specification set in WP-1.

Table 6: Trial sample test results.

Property, metric and test	Test Method	Target Value	BRC022001-1
Kinematic Viscosity (40°C, cSt)	ASTM D 445	10-500	56,52
Pour Point (°C)	ASTM D 97	max -10	-10
Flash Point (°C)	ASTM D 92	min 140	>140
Total Acid Number (TAN) (mg KOH/g)	ASTM D 974	max 5,0	2,0
Foam Test (mL/mL, Sq I)	ASTM D 892	max 50/0	30/0
SRV Friction Test (fmax) (for Al/Ti)	ASTM D 6425	max 0,500	0,42
SRV EP Step Test (N) (for Al/Ti)	ASTM D 5706	min 400	400
Tapping Torque Test for Al/Ti (Nm)	BLN 105	max 350	152,4
Rust Test	ASTM D 665 A	Pass	Pass
Aluminum Staining Test	BLN 99	Pass	Pass
Wettability Test	BLN 172	Good	Good
Cleanability Test	BLN 147	Must be easy	Easy
Biodegradation Test	OECD 301	min %80	In Testing Phase

Property, metric and test	Test Method	Target Value	BRC022001-2	BRC022001-3
Kinematic Viscosity (40°C, cSt)	ASTM D 445	10-500	222,42	208,3
Pour Point (°C)	ASTM D 97	max -10	<-10	<-10
Flash Point (°C)	ASTM D 92	min 140	>140	>140
Total Acid Number (TAN) (mg KOH/g)	ASTM D 974	max 5,0	<5	<5
Foam Test (mL/mL, Kd I)	ASTM D 892	max 50/0	30/0	20/0
SRV Wear Test (fmax) (for Al/Ti)	ASTM D 6425	max 0,500	0,147	0,192
SRV EP Step Test (N) (for Al/Ti)	ASTM D 5706	min 400	400	500
Tapping Torque Test Al 6061 (Nm)	BLN 105	max 350	82,8	91,6
Tapping Torque Test Al 7075 (Nm)			166,8	175,5
Tapping Torque Test Ti-6Al-4V (Nm)			119,6	126,0
Rust Test	ASTM D 665 A	Pass	Pass	Pass
Aluminum Staining Test	BLN 99	Pass	Pass	Pass
Wettability Test	BLN 172	Good	Good	Good
Cleanability Test	BLN 147	Should be easy	Easy	Easy
Biodegradability Test	OECD 301	min %80	To be tested	To be tested

- Industrial trial test results will be shared.