ANEXOS

ÍNDICE

ANEXO 1

Tabla de Especificaciones del Biodiesel Según NTP 321.125.2008.

BIODIESEL. ESPECIFICACIONES

TABLA 1 – Especificaciones del Biodiesel (B100)

Propiedad	**Método de Ensayo (a)**	Biodiesel B100	Unidades
Contenido de calcio y magnesio, combinado	**EN 14538**	5 Máx.	ppm (µg / g)
Punto de inflamación. (Copa cerrada)	**ASTM D 93**	93 mín.	°C
Control de Alcohol (uno de los siguientes debe ser cumplido:)			
1. Contenido de Metanol 2. Punto de inflamación	**EN 14110** **ASTM D 93**	0,2 Máx. 130,0 mín.	% volumen °C
Agua y sedimento	**ASTM D 2709**	0,050 Máx.	% volumen
Viscosidad cinemática a 40 °C	**ASTM D 445**	1,9 – 6,0 (b)	mm^2/s
Ceniza sulfatada	**ASTM D 874**	0,020 Máx.	% masa
Azufre (c)	**ASTM D 5453**	0,0015 Máx. (15)	% masa (ppm)
Corrosión a la lámina de cobre	**ASTM D 130**	N° 3	
Número Cetano	**ASTM D 613**	47 mín.	
Punto nube	**ASTM D 2500**	Reportar (d)	°C
Residuo de carbón (e)	**ASTM D 4530**	0,050 Máx.	% masa
Número acidez	**ASTM D 664**	0,50 Máx.	Mg KOH / g
Glicerina libre	**ASTM D 6584**	0,020 Max.	% masa
Glicerina total	**ASTM D 6584**	0,240 Máx.	% masa
Contenido de fósforo	**ASTM D 4951**	0,001 Máx	% masa
Temperatura de destilación. Temperatura del 90% de recuperado equivalente a presión atmosférica.	**ASTM D 1160**	360 Máx.	°C
Contenido de sodio y potasio, combinado	**EN 14538**	5 Máx.	ppm (µg / g)
Estabilidad a la oxidación	**EN 14112**	3 min.	horas

(a) Los métodos de ensayo indicados son los aprobados como métodos dirimentes. Otros métodos aceptables se listan en el apartado 5.1

(b) Véase B.3.1. El límite de viscosidad de 6,0 mm^2/s es mayor que el del combustible diesel derivado del petróleo lo que debe tomarse en cuenta cuando se mezclan, o cuando se use como B100 puro.

(c) Pueden ser de aplicación otras limitaciones del contenido de azufre en determinadas áreas del territorio nacional.

(d) El punto de nube del biodiesel es generalmente mayor que el del combustible diesel derivado del petróleo lo que debe tomarse en cuenta cuando se mezclan, o cuando se use como B100 puro.

(e) El residuo de carbón debe ser realizado sobre el 100 % de la muestra (véase 5.1.10)

INDECOPI. NTP 321.125:2008. BIOCOMBUSTIBLES Biodiesel, 2008.

ANEXO 2

Tabla de Especificaciones del Diesel Según NTP 321.003.2003.

DIESEL. ESPECIFICACIONES

TABLA 1 – Especificaciones Diesel N° 1, Diesel N°2 S-350 y Diesel N°2 S-50

CARACTERISTICAS	ESPECIFICACIONES						METODO DE ENSAYO		
	DIESEL N° 1		DIESEL N° 2 (D2 S-350)		DIESEL N° 2 (D2 S-50)		ASTM	ISO	NTP
	Min.	Max.	Min.	Max.	Min.	Max.			
VOLATILIDAD									
Destilación							D 86: 04	3405	321.023
% Vol. Recuperado a 250 °C				65.0		65.0			
% Vol. Recuperado a 350 °C			80.0		80.0				
90% recuperado, °C		288.0							
95% recuperado, °C				360.0		360.0			
Punto de inflamación Pensky Martens, °C			55.0		55.0		D 93:02a	2719	321.024
Punto de inflamación Tag Copa Cerrada, °C	38.0						D 56:02a		321.105
Densidad a 15°C, Kg/m³			820	845	820	845	D 1298:99 D 4052:02	3675	
FLUIDEZ									
Viscosidad Cinemática a 40°C, cSt	1.300	2.400	2.000	4.500	2.000	4.500	D 445:04	3104	321.031
Punto de Escurrimiento, °C		-12					D 97:04	3016	
Punto de Niebla, °C (A)							D 2500:02 e1	3015	
COMPOSICION									
Número de Cetano (B)	40		51		51		D 613:03b	5165	
Indice de Cetano	40		46		46		D 4737:03 D 976:04a	4264	
Cenizas, % masa		0,010		0,010		0,010	D 482:03	6245	
Residuo de Carbón Ramsbottom, 10% fondos, % masa (C)		0.15					D 524:03 D 189:01	4262 6615	
Residuo de Carbón Conradson, 10% fondos, % masa				0.3		0.3	D 4530:03 D 189:01	10370 6615	
Aromáticos, % Vol				35.0		35.0	D 1319:03	3837	
Azufre total, mg / Kg		1500					D 129:00 D 2622:03 D 4294:03 D 5453:03a D 4045:04 D 1266:98 (03)	14596 8754	
				350			D 5453:03a D 2622:03 D 4294:03 D 1266:98 (03)	14596 8754 4260	
						50	D 5453:03a D 2622:03 D 1266:98 (03)	14596 4260	
CORROSIVIDAD									
Corrosión a la lámina de Cobre, 3h, 50 °C, N°		3		1		1	D 130:04	2160	321.021
Estabilidad a la Oxidación, mg / 100ml				25.0		25.0	D 2274:03a	12205	
Acidez Total, mg KOH/g				0.08		0.08	D 974:01 e1	6618	
CONTAMINANTES									
Agua y Sedimentos, % Vol		0,05		0,05		0,05	D 1796:97 (02) D 2709:96 (01)	3734	321.029
Material Particulado, mg/L				24.0		24.0	D 6217:98 (03)		
LUBRICIDAD									
Lubricidad, diámetro rasgado de uso corregido, HFRR a 60 °C, mm				0.46		0.46	D 6079:02	12156	
OTROS									
Contenido de FAME, % Vol (D)				5		No detectable	(E)		

(A) Cuando el cliente requiera se determinará el Punto de Niebla
(B) En caso de no contar con el equipo del Método de Ensayo D 613 (Número de Cetano), se calculará el Indice de Cetano.
(C) En caso de no contar con el equipo, se calculará esta propiedad utilizando el Apéndice X1 del Método de Ensayo ASTM D524:03, que relaciona el ensayo de Carbón Conradson (Método de Ensayo ASTM D189:01) con el Carbón Ramsbottom.
(D) FAME = Fatty Acid Methyl Esters
(E) Método de ensayo EN 14078

INDECOPI. NTP 321.003:2005. PETROLEO Y DERIVADOS. Diesel. Especificaciones, 2005.

ANEXO 3

Tabla de Especificaciones de las Mezclas B6 – B20 Según ASTM D-7467.

D7467 – 10

TABLE 1 Detailed Requirements for B6 to B20 Biodiesel Blends

Property	Test Method	Grade		
		B6 to B20 S15	B6 to B20 S500[A]	B6 to B20 S5000[B]
Acid Number, mg KOH/g, max	D664	0.3	0.3	0.3
Viscosity, mm^2/s at 40°C	D445	1.9-4.1[C]	1.9-4.1[C]	1.9- 4.1[C]
Flash Point, °C, min	D93	52[D]	52[D]	52[D]
Cloud Point, °C, max or LTFT/CFPP, °C, max	D2500, D4539, D6371	[E]	[E]	[E]
Sulfur Content, (µg/g)	D5453	15	...	...
mass %, max	D2622	...	0.05	...
mass %, max	D129	...	...	0.50
Distillation Temperature, °C, 90% vol recovered, max	D86	343	343	343
Ramsbottom Carbon Residue on 10% bottoms, mass %, max	D524	0.35	0.35	0.35
Cetane Number, min	D613[F]	40[G]	40[G]	40[G]
One of the following must be met: (1) Cetane index, min.	D976-80[H]	40	40	40
(2) Aromaticity, %vol, max	D1319-03[H]	35	35	...
Ash Content, mass%, max	D482	0.01	0.01	0.01
Water and Sediment, volume%, max	D2709	0.05	0.05	0.05
Copper Corrosion, 3 h at 50°C, max	D130	No. 3	No. 3	No. 3
Biodiesel Content, % (V/V)	D7371	6. - 20.	6. - 20.	6. - 20.
Oxidation Stability, hours, min	EN 15751	6	6	6
Lubricity, HFRR at 60°C, micron (µm), max	D6079	520[I]	520[I]	520[I]

[A] Under United States of America regulations, if Grades B6-20 S500 are sold for tax exempt purposes then, at, or beyond terminal storage tanks, they are required by 26 CFR Part 48 to contain the dye Solvent Red 164 at a concentration spectrally equivalent to 3.9 lb per thousand barrels of the solid dye standard Solvent Red 164, or the tax must be collected.

[B] Under United States of America regulations, Grades B6-20 S5000 are required by 40 CFR part 80 to contain a sufficient amount of the dye Solvent Red 164 so its presence is visually apparent. At or beyond terminal storage tanks, they are required by 26 CFR Part 48 to contain the dye Solvent Red 164 at a concentration spectrally equivalent to 3.9 lb per thousand barrels of the solid dye standard Solvent Red 26.

[C] If Grade No. 1-D or blends of Grade No. 1-D and Grade No. 2-D diesel fuel are used, the minimum viscosity shall be 1.3 mm^2/s.

[D] If Grade No. 1-D or blends of Grade No. 1-D and Grade No. 2-D diesel fuel are used, or a cloud point of less than -12°C is specified, the minimum flash point shall be 38°C.

[E] It is unrealistic to specify low temperature properties that will ensure satisfactory operation at all ambient conditions. In general, cloud point (or wax appearance point) Low Temperature Flow Test, and Cold Filter Plugging Point Test may be useful to estimate vehicle low temperature operability limits but their use with B6 to B20 has not been validated. However, satisfactory operation below the cloud point (or wax appearance point) may be achieved depending on equipment design, operating conditions, and the use of flow-improver additives as described in X3.1.2. Appropriate low temperature operability properties should be agreed upon between the fuel supplier and purchaser for the intended use and expected ambient temperatures. Test Methods D4539 and D6371 may be especially useful to estimate vehicle low temperature operability limits when flow improvers are used but their use with B6 to B20 from a full range of biodiesel feedstock sources has not been validated. Due to fuel delivery system, engine design, and test method differences, low temperature operability tests may not provide the same degree of protection in various vehicle operating classes. Tenth percentile minimum air temperatures for U.S. locations are provided in Appendix X3 as a means of estimating expected regional temperatures. The tenth percentile minimum air temperatures may be used to estimate expected regional target temperatures for use with Test Methods D2500, D4539, and D6371. Refer to X3.1.3 for further general guidance on test application.

[F] Calculated cetane index approximation, Test Method D4737, is not applicable to biodiesel blends.

[G] Low ambient temperatures, as well as engine operation at high altitudes, may require the use of fuels with higher cetane ratings. If the diesel fuel is qualified under Table 1 of Specification D975 for cetane, it is not necessary to measure the cetane number of the blend. This is because the cetane number of the individual blend components will be at least 40, so the resulting blend will also be at least 40 cetane number.

[H] These test methods are specified in 40 CFR Part 80.

[I] If the diesel fuel is qualified under Table 1 of Specification D975 for lubricity, it is not necessary to measure the lubricity of the blend. This is because the lubricity of the individual blend components will be less than 520 micron (µm) so the resulting blend will also be less than 520 (µm).

AMERICAN SOCIETY FOR TESTING AND MATERIALS. ASTM 7467. Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20), 2010.

ANEXO 4

Conclusiones de Investigaciones del Efecto del Biodiesel en el Funcionamiento de Motor

Table 2
Estimated share of literature (in percentage of number of publications) reporting decreases, similarities or increases in engine performance and emissions using biodiesel and diesel fuels

	Increases	Same[a]	Decreases	Synergies
Effective power (full load)	–	2	96	2
Brake-specific fuel consumption	98	2	–	–
Thermal efficiency	8	80	4	8
NO_x emissions	85	10	5	–
PM emissions	3	2	95	–
THC emissions	1	3	95	1
CO emissions	2	7	90	1

[a]Many references included in this category have reported both increases and decreases depending on engine load conditions, engine type, engine operation temperature, etc.

LAPUERTA, Magín. Effect of Biodiesel Fuels on Diesel Engine Emissions, 2007.

ANEXO 5

Aumento del Consumo de Combustible en Base al Porcentaje de Biodiesel Según Investigaciones Desarrolladas por la EPA

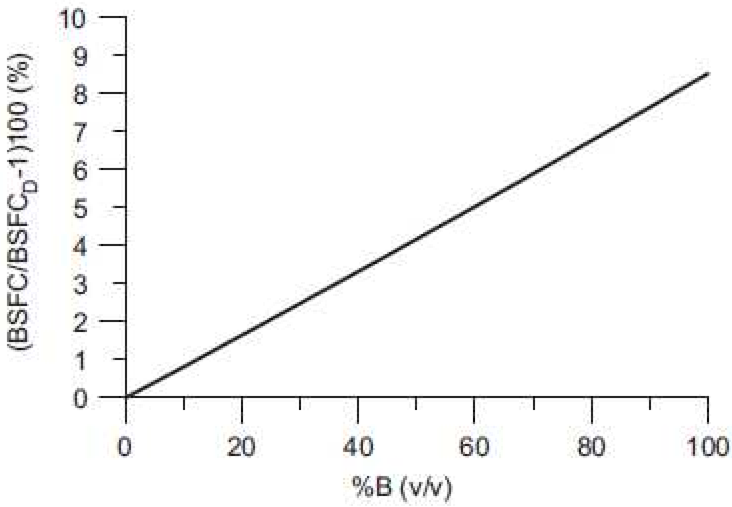
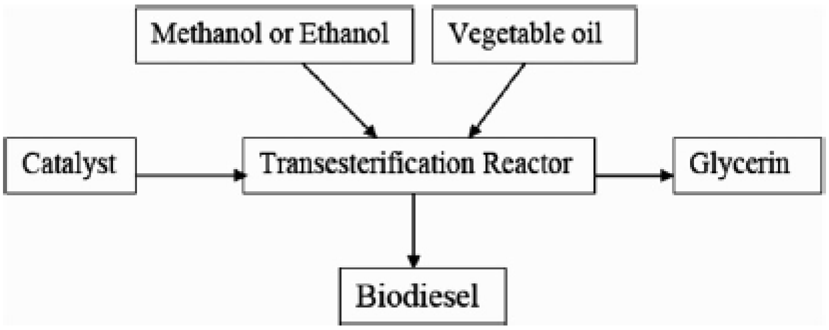


Fig. 2. Mean increase in *bsfc* as the biodiesel content increases (trend obtained from Ref. [46] for heavy-duty engines with no EGR or aftertreatmen system).

LAPUERTA, Magín. Effect of Biodiesel Fuels on Diesel Engine Emissions, 2007.

ANEXO 6

Diagrama del Proceso de Transesterificación de Biodiesel



BALAT, Mustafa. A Critical Review of Biodiesel as a Vehicular Fuel. (2008)

ANEXO 7

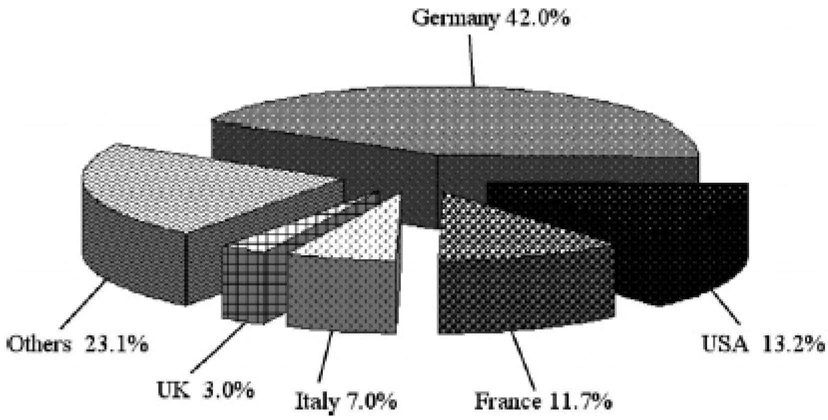
Especificaciones de los Combustibles Diesel y Biodiesel Según ASTM

Fuel property	Diesel	Bio-diesel
Fuel standard	ASTM D975	ASTM PS 121
Fuel composition	C10–C21 HC	C12–C22 FAME
Lower heating value (MJ/m^3)	36.6×10^3	32.6×10^3
Kinematic viscosity at 40 °C (mm^2/s)	1.3–4.1	1.9–6.0
Specific gravity at 15.5 °C	0.85	0.88
Density at 15 °C (kg/m^3)	848	878
Water (ppm by wt.)	161	0.05% max
Carbon (wt%)	87	77
Hydrogen (wt%)	13	12
Oxygen (by diff.) (wt%)	0	11
Sulfur (wt%)	0.05 max	0.0–0.0024
Boiling point (°C)	188–343	182–338
Flash point (°C)	60–80	100–170
Cloud point (°C)	−15 to 5	−3 to 12
Pour point (°C)	−35 to −15	−15 to 10
Cetane number	40–55	48–65
Stoichiometric air/fuel ratio (wt./wt.)	15	13.8

BALAT, Mustafa. A Critical Review of Biodiesel as a Vehicular Fuel. (2008)

ANEXO 8

Porcentaje de los 5 Países que Más Producen Biodiesel en el Año 2006



BALAT, Mustafa. A Critical Review of Biodiesel as a Vehicular Fuel. (2008)

ANEXO 9

Propiedades de Distintos Tipos de Biodiesel

Properties	Biodiesel (vegetable oil methyl ester)					
	Peanut	Soyabean	Palm	Sunflower	Linseed	Tallow
Kinematic viscosity at 37.8 °C	4.9	4.5	5.7	4.6	3.59[a]	—
Cetane number	54	45	62	49	52	—
Lower heating value (MJ/l)	33.6	33.5	33.5	33.5	35.3	—
Cloud point	5	1	13	1	—	12
Pour point	—	−7	—	—	−15	9
Flash point	176	178	164	183	172	96
Density (g/ml)	0.883	0.885	0.88	0.86	0.874	—
Carbon residue (wt%)	—	1.74	—	—	1.83	—

[a]At 40 °C.

AGARWAL, Avinash. Biofiels (alcohols and biodiesel) Applications as Fuels for Combustion Internal Engines. (2006)